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THE COMPOSITE FIELD CIRCUIT.

It has been recognized for several years past by designers of electrical machinery that the employment of iron having high permeable qualities effects a considerable economy both in construction and operation. Steel castings were introduced with the object of attaining these results, and the use of steel has rapidly extended both in the size of the castings and their number. Owing, however, to the generally unreliable magnetic qualities of cast steel and the fact that it must be cast by founders making a specialty of such work, then shipped to the manufacturer of the electrical machinery, its use has been more or less limited to the smaller types of dynamos and motors. Wrought-iron forgings are excellent but expensive, while soft cast-iron field frames not only increase the amount of copper, but also the magnetic leakage and energy of excitation. The solution of the problem, especially for large machines, seems to be to use a composite magnetic circuit, consisting of a soft cast-iron frame or yoke with wrought-iron field-magnet waists. Formerly the surfaces between the two were carefully finished and bolted together, but of late the more common practice is to suitably shape the waists and cast them in, at the same time providing at least twice the area of the waist cross-section for contact between the cast and wrought-iron parts. This method of cast-welding is very valuable inasmuch as it greatly facilitates the construction of laminated pole-pieces. The magnetic reluctance of such joints is almost an unknown quantity, and offers therefore a good subject for investigation. Any method of obtaining a perfect cast-welded joint would have an extensive application in other ways besides in the magnetic circuits of dynamo-electric machinery.

ELECTRIC BOATS.

Since the World's Fair at Chicago in 1893 little attention has been given to the subject of electrical propulsion for boats, and the few craft of this character thus far built have been as a rule intended for pleasure only. The availability of electrically driven boats for commercial uses is yet an unsolved problem, although the electric launches at the Columbian Exposition netted a handsome revenue for the projectors of the enterprise. The question of economy has no doubt exerted a deterrent influence upon enterprise and progress in this direction. In the selection of a pleasure craft, if the main questions to be considered are comparative cleanliness, economy in space occupied by machinery and freedom from vibration, gases, heat, etc., then no other class can compare with the electrically propelled boat in these points. Craft of this class hitherto turned out have been small, coming under the classification of "launches," and while they have proved to be quite economical to operate—where the proper facilities for charging the batteries were provided—and easy to control, they have not met with a very extensive application. In this connection it is interesting to note that progress in the development of electrical navigation has recently received a stimulus in the construction by Mr. John Jacob Astor of an electric "yacht," which enjoys the distinction of being the largest and most complete electric boat ever built. Our readers will find a description of this interesting craft on another page in this issue. No money has been spared in her construction and equipment, and she will no doubt be able to furnish some valuable data respecting the probable commercial availability of craft of this sort. It is greatly to Mr. Astor's credit that he should further the aims of industry in the production of the *Utopian*. No better use can be made of surplus wealth than to exploit ideas and inventions that pos-

sess promise of material benefit to commerce and if the example set by Mr. Astor were more generally followed by our wealthy and public-spirited citizens the world would be the gainer.

M. HENRI MOISSAN'S LECTURE.

Those whose privilege it was to attend the lecture of M. Henri Moissan on Tuesday evening, Oct. 27, had the pleasure of listening to a most instructive discourse by one who has undoubtedly contributed more than any other investigator to existing knowledge concerning metallic carbides. The lecture prominently illustrated the dependence which one branch of science may have upon another, in this case the bearing of electricity upon the study of chemical compounds. M. Moissan first brought to his aid the intense heat of the electric furnace in 1893, prior to which time no definite compounds of carbon with the metals aside from a few impure acetylides of the alkaline earths were known. Owing to the necessity of using carbon electrodes, metallic carbides were formed, so that almost inadvertently, it may be said, there was opened up the line of work which M. Moissan has so successfully carried out. He has discovered with the aid of the electric furnace about 20 metallic carbides, the properties of which have been carefully studied and classified according to their action when combined with water. This classification results in the formation of a group containing tungsten, molybdenum, titanium, zirconium and chromium which fail to decompose water at ordinary temperatures; a second group comprising lithium, calcium, strontium and barium which react with water, forming pure acetylene; a third in which are contained aluminum and beryllium forming pure methane; manganese forms a mixture of equal volumes of methane and hydrogen while the metals cerium, lanthanum, yttrium and thorium belong to a group which reacts with cold water, forming a mixture of hydrogen, acetylene, methane, ethylene and other constituents. Uranium carbide is perhaps the most interesting as its reaction with water forms not only hydrogen, ethylene and methane but also hydrocarbons both solid and liquid. Taking advantage of the stability of iron, inasmuch as it forms no crystalline carbide when acted upon by the intense heat of the electric furnace, M. Moissan has been able to produce diamonds by subjecting intensely heated carbon to the enormous pressure due to the contraction of iron when cooling. Another interesting branch of the subject of metallic carbides is the relation which they bear to the geological question of the origin of petroleum deposits. The various lines of research into which this general subject divides, although of but indirect interest to the electrician, still affords some conception of the new innovations in the ever-widening field of electrical applications. In connection with M. Moissan's presence in this country it is interesting to note his views regarding the commercial possibilities of acetylene gas. He states that the present cost of production of calcium carbide is about $80 per ton, and therefore although acetylene is a brilliant illuminant it is very expensive. All Europe, he said, smiled over the extravagant claims of several American promotors to the effect that calcium carbide could be manufactured for $25 per ton. M. Moissan was extremely well pleased with his visit to American universities and the splendid equipments which they possess, and spoke most highly of the cordial reception which he received during his brief stay in this country.

THE BRUSSELS EXPOSITION.

Little attention has been given in the United States to the exposition which is to be opened in Brussels in May, 1897, although it will undoubtedly afford to American manufacturers an excellent opportunity to open up a larger European market for their products. The enterprise was originated and planned on a comparatively small scale, and although local in scope, it has been given an important character by the action of the Belgian King and Government in placing upon it the stamp of Government favor, thus adding dignity as well as importance to the project. Foreign manufacturers, therefore, who wish to exhibit, will be encouraged to participate by reason of the Government protection and guaranties afforded under the new order of things. The exposition will be a unique one in that it will be divided into two parts, separated by a distance of eight miles. One section will be situated in the Parc du Tervuren, a popular suburb of Brussels, while the other section will occupy a space in the Parc du Cinquantenaire, in the city. For the purpose of facilitating travel between the two points a broad avenue is being constructed at great expense, on both sides of which an electric railway will be in operation. Space will be provided for pedestrians, carriages and bicycles. It is calculated that the electric cars will be able to cover the distance between the two portions of the exposition in about 20 minutes. The section of the exhibition in the Parc du Cinquantenaire will constitute the more important of the two, and here the main buildings will be erected. Such matters of detail as the utilization of space, apportionment, etc., have not yet been settled, but we are informed that the interests of foreign exhibitors will be properly taken ca[illegible]of. The exhibition will be divided into 14 sections, 56 groups [illegible]nd 199 classes, covering all branches of art, industry and science, and it is proposed to show in the international sections progress along these lines, including new inventions and discoveries of value and importance. There is every reason to believe that foreign participation will be of the most generous character. The United States has already made a liberal grant, so have France, England and Germany, and other interested countries have signified their intention of being properly represented at the Exposition. The South American Republics are taking a lively interest in the enterprise, and most of these governments will also be represented. No attempt is being made to eclipse previous international expositions. The Belgian authorities indeed modestly acknowledge that their enterprise will not be a large one, but every endeavor will be put forth to make it comprehensive and thoroughly representative and international. The grounds about the buildings will be rendered as attractive as Belgian skill and art can make them, and that means a great deal, and among the side attractions will be a miscellaneous aggregation of representative oddities from all parts of the world. Work on some of the buildings has already commenced. The fact that the exposition has become a national enterprise, more for glory than speculation, leads to the belief that exhibitors will be free from undue exactions and petty annoyances, and that every encouragement will be afforded by the projectors to foreign exhibitors to participate in the exposition. In view of all these facts we desire to call the attention of American manufacturers to the opportunity thus presented to compete for European business. Many American products are growing in favor on the Continent, and a well-arranged exhibit at Brussels would certainly result in a wholesome expansion in our foreign trade.

Electric Currents Through Rarefied Air.

In their investigations in this line Lord Kelvin, J. T. Bottomley and Magnus McLean worked in air rarefied to five-millionths of its density. The experimental tube contained two pointed aluminum wires. At ordinary atmospheric density 2000 to 3000 volts were required to start a discharge; the current then increased more rapidly than the voltage. With decreasing density the E. M. F. required to start a current decreased, the current increasing, the same current being obtained by smaller potentials in more and more rarefied air. Thus a current of 56 micro-amperes resulted with differences of potentials of 7400, 1090, 700, 370, 405, 570 volts when the densities were 1, 0.058, 0.0093, 0.0007, 0.00006 and 0.000024. At further reduction of the pressure the potentials increased, while the currents diminished; at the minimum density, 5×10^{-6}, 3000, 5000, 8000 volts, gave currents of 1.3, 4.4, 14.6 micro-amperes.

The Calibration of a Bridge Wire.

BY W. M. STINE.

Of late, interest in this subject seems to have been revived, and several new methods and modifications have been proposed. That there is need of development no one familiar with the academic methods prescribed by several works on measurements will have a doubt. The original method of Prof. Carey Foster, in which a "gauge" of low resistance was employed, is both tedious and intricate, and those who have followed him have rather increased the complexity.

To be sure, in modern methods of electrical measurements there is a lessened necessity for the calibration of bridge wires, and this has been further emphasized by improved methods of wire manufacture, producing wires so fairly uniform that it is only in the most accurate work that they need be calibrated. But the necessity for calibration occasionally arises, and it is convenient to have a rapid and accurate method for the process.

The method given below was devised by the writer several years since. The aim was to present to his students a simple, direct and accurate method.

Since calibrated bridge wires are mostly necessary in connection with the Carey-Foster apparatus for comparing resistances, the method was based upon this process.

The Auxiliary Wire Method.—It is necessary to know two properties of the wire—the space rate of change of its resistance or calibration, and the resistance of unit length, commonly denoted by the symbol ρ. Both these factors may be simultaneously determined.

The wire under test is connected to a suitable commutator, and in a gap on one side of the bridge circuit an auxiliary wire is inserted.

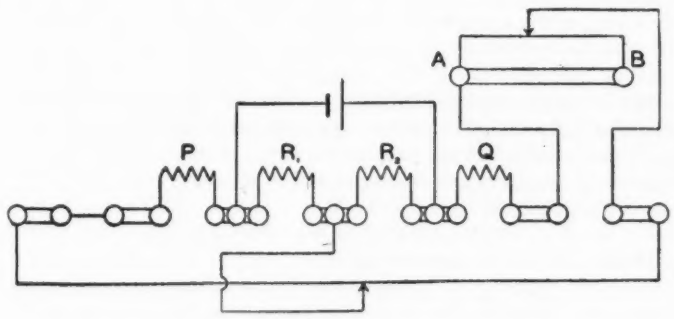


FIG. 1.

This auxiliary wire may be an ordinary slide wire, or a special device. In its selection, for convenience, it may be nearly similar to the wire under test. The special device is readily constructed. Two double binding-posts are attached to the ends of a board, the posts being placed about one half metre apart. A suitable slide, making a spring contact with the wire, is moved along a groove cut in the board parallel with the wire. All connections should be of low resistance. The connections are shown diagrammatically in Fig. 1.

Here P is a standard ohm whose value is accurately known ; Q is a nearly equal resistance, preferably a one-ohm coil whose value is known to be less than P. R_1 and R_2 are the usual ratio coils, while $A\ B$ is the auxiliary wire.

The first step is to make $Q = P$.

This is done by placing a piece of copper wire in series with Q and adjusting its length until equality of resistance is obtained. This equality is determined, when upon reversal

$$X - X_2 = O$$

the quantities X_1 and X_2 being the scale readings. This relation follows directly from the general equation of the Carey-Foster method.

$$P - Q = (X_1 - X_2)\,\rho$$

One of the standards P and Q, preferably P, is now shunted by a resistance box. The particular value to be given the shunt is determined by trial. The element determining this is the desired length of wire for the first calibration. Suppose this to be 10 centimetres. The sliding contact is placed on the desired point and the balance obtained by charging the resistance of the shunt. The resistance of this section of wire is then calculated from the resistance of P and the shunt.

To proceed, the commutator is now reversed and the balance obtained by moving the contact of the auxiliary wire. The contact to the wire under test is then moved along to a second point 10 centimetres from the first, the commutator reversed and the balance again obtained by adjusting the shunt. This process is repeated until one half the wire is calibrated. The other half of the wire is then calibrated by the same method. The values for P can be directly obtained from the calibration.

Another interpretation is sometimes given to calibration—the division of the wire into spaces of equal resistance. This is accomplished in much the same way, by using the first value of the shunt throughout the succeeding tests.

Further Opposition to the Bell Telephone Company.

BY E. F. FROST.

The argument of the brief filed by the Standard Telephone Company in support of the position of the appellant, the United States, is based upon the declaration of the Bell Company before the various courts, and the sustaining of its declaration by the courts, to the effect that Bell's invention was for the only possible and only known method of transmitting speech telephonically ; that this declaration was made and sustained long after the Bell Company had become owners of Berliner's microphone invention. The argument deduces from these facts that therefore Berliner's method is the same, and is included under Bell's patent.

This is seemingly strong ground, for Bell's method was for the transmission of speech by undulating a current of electricity similar in form to sound waves in air, and Berliner's method utilizes the same undulations.

This argument is defective, because Berliner's method claim is not for the transmission of speech by undulating a current of electricity, but is a claim for a method not of transmitting speech but for producing the undulations of the current which are necessary to the transmission of speech, and his method consists in holding the electrode in constant contact. In other words, Berliner recognizes Bell's right to the transmission of speech by means of a specially undulated current of electricity, but he asserts his own right to a method of making those undulations. So that Berliner's claim is not for the method of transmitting speech, but for a method of undulating a current of electricity. He tells in his claim what he wants to do, and then his method of doing it. Berliner's claim is: "The method (what he wants to do follows) of producing in a circuit electrical undulations similar in form to sound waves (now comes his method) by causing the sound waves to vary the pressure between electrodes in constant contact (what follows is explanatory), so as strengthen and weaken, and thereby increase and diminish the resistance of the circuit, substantially as described."

The brief goes on at some length, quoting the testimony and argument already used before the courts, as well as quoting decisions bearing on method claims in general, to uphold its position that Bell's and Berliner's methods are one and the same. It seems clear, however, that this is an error as wide as to call white black, in view of the express language of the claims of the two patents.

The brief, however, takes strong ground in showing that Berliner claimed no method prior to his amendment to his application in 1880, which amendment it claims to be irregular, but upon what ground is not specified.

Again, the brief takes strong ground in showing that Bell's mercury transmitter varied the resistance of the circuit without breaking contact between electrodes.

But now follows a tedious argument to show that variation of pressure between electrodes is not the necessary thing to undulate an electric current but that something else is. This argument labors to show that it is a variation of surface contact that is involved, and it ignores the language of Berliner's claim to constant contact entirely as inclusive of whatever may take place under such contact in the production of undulations.

Why all this labor of the mountain to upset one theory and set up another, when the language of the claim has to do with whatever may take place under constant constant ?

The brief says, page 40, " Constancy of contact is not our question; area of contact is."

Why can it not be recognized that all microphones work alike and whatever takes place physically is the same in all?

In referring to Edison's patent No. 474,230, stress is laid on the variable amount of surface short-circuited to uphold their theory but the fact of constant contact is ignored. It is astonishing that the fact that this same patent antedated Berliner's application in its filing is not even mentioned.

The last argument of the brief is to the effect that the Berliner apparatus claims are void because identical with that of the Berliner patent of 1880.

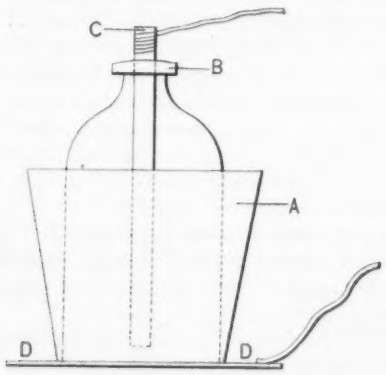
To sum up, the Standard Company's brief is weak, in that it confounds two distinct and separate methods—in that its premise is false—in that it labors to upset one theory and supply another, neither of which are in any way involved in the discussion of the method of the Berliner claim.

An Inexpensive, Adjustable Condenser for High Potentials.

BY LUCIEN I. BLAKE.

One of the main practical difficulties of high-potential apparatus has been the condenser. The historic Leyden jar, or some modification of it, employing glass as a dielectric and tin-foil coatings, has been the chief, though unsatisfactory and easily destructible, condenser of the laboratory. Various solid dielectrics have been used in place of glass, but all break down readily under high pressures, and have not proven convenient to construct in adjustable capacities. All have been expensive. The recent attention given to electrostatic work, especially with X-ray apparatus employing Tesla coils, emphasizes the need of a cheap adjustable and non-breakable condenser. Such a condenser has been devised and constantly employed for nearly a year now in the physical laboratory of the University of Kansas. Its expense of construction is trivial; it can be built in any capacity, and delicately tuned to any circuit, and is readily adjustable. It has proven itself so vastly superior to any other type of condenser known to the writer that a description of it may prove useful to other experimenters.

The accompanying figure will show at a glance the form which the writer has developed as the most convenient portable one for



Adjustable Condenser.

ordinary work. *A* is a tin jar 7 inches high, 8 inches diameter at top, and 5 inches diameter at bottom ; *B* is a two-quart glass bottle of ordinary glass ; *C* is an electric light carbon ; *D* is a sheet of tin. The bottle is filled to any height with water, slightly acidulated or containing common salt, and a similar solution is poured into the tin jar to the same height. The jar is then placed upon a sheet of tin, which is connected with one electrode, while the carbon-rod is connected to the other, of any apparatus used. A number of these jars may be connected upon the same tin and any capacity obtained. Liquid may be poured into each jar until the proper tuning is obtained, and this is determined readily by the intensity of small sparks which appear on the sides of the bottles at the surface of the water.

The original idea of an electrolyte in place of tin-foil coating is due to Mr. F. C. Penfield, a student in the laboratory. If the outer tin jars are built in a "nest," the apparatus is easily packed for transportation. This form of condenser has proven applicable to every type of laboratory work. Should a bottle be pierced by a spark, it is quickly replaced by another bottle. Boiled linseed oil rubbed on the exposed outer surface of the bottles will prevent sparking over. Such condensers have been standing over 500,000 volts pressure continually in this laboratory, and are used almost exclusively now in all condenser work.

A Carbon Cell Without a Metal Electrode.

We have recently received a communication from Dr. D. Tommasi referring to articles published during the past Summer on the invention of Dr. Alfred Coehn of a new cell, in which the soluble negative electrode instead of being of metal was composed of carbon. Dr. Tommasi believes that Dr. Coehn deserves no particular credit for his work inasmuch as he considers the idea one which was put in practice some 12 years ago by himself. Dr. Tommasi states that the same idea was presented before l'Académie des Sciences de Paris in the month of June, 1884. This cell, constructed by M. Radiguet and presented to the public under the name of a cell having carbon electrodes, and shown in two forms by Dr. Tommasi—one being rectangular, the other cylindrical—is given in a description on page 308 of his Traité des Piles.

The following is a brief description of the second form: In the centre of a cylindrical glass jar was placed a carbon rod covered with a thick layer of peroxide of lead and enclosed in a linen sack. The electrode thus enveloped was placed in a perforated carbon tube; the whole occupies the centre of the glass jar, which in turn is about half filled with fragments of retort carbon together with a concentrated solution of chloride of sodium and chloride of calcium ; this latter, which is extremely hyprometric, prevents or at least greatly retards the evaporation of the water. The carbon fragments which are not in the bottom are covered with a layer of chloride of calcium. It is to be added that this cell was exhibited in the year 1885 at the Lenten reunion of the Société Française de Physique, where on account of the absence of all metals it nonplussed a number of experts. At that time the heat of combination of the peroxide of lead was not known. It was not until some time later, when Tscheltzoix had recognized that the passage of a molecule of protoxide of lead to the state of peroxide liberates 12.14 calories, that Dr. Tommasi could give the theory of his carbon electrode cell [1].

It is perhaps not superfluous to repeat this theory. The heat of combination of anhydrous protoxide of lead (PbO) being 51 calories, the heat of combination of the peroxide (PbO_2) is 63.14 calories. Beginning with the action exercised by the carbon on water[2], the action which goes on in the battery can next be explained.

The carbon which decomposes water in the closed circuit (as in the case of a metal) forms carbonic acid with the liberation of hydrogen, according to the formula

$$C + 2H_2O = CO_2 + 4H.$$

The thermal effect of this reaction is

102.6 calories — 138 calories = 35.4 calories.

On the other hand, in the sack which takes the place of the porous jar, there is a reduction of the peroxide of lead and a formation of water, according to the equation

$$PbO_2 + 4H = Pb + 2H_2O,$$

and the thermal effect of this reaction is

138 calories — 63.14 calories = 74.86 calories.

The heat resulting from these two reactions is the algebraic sum of the thermal effects, which is 74.86 calories—35.4 calories = 39.46 calories; as the volt corresponds, according to certain authorities, to 46.3 calories, the E. M. F. of the carbon electrode cell would be $39.46 \div 46.3 = 0.85$ volt.

If we accept the figure 47.16 calories adopted by others, we have $39.46 \div 47.16 = 0.84$ volt. Direct measurements give from 0.6 to 0.7 volt. It is easy to explain this difference when it is considered that the cell readily polarizes and that besides the carbonic acid, carbonic oxide may be formed, which latter tends to diminish the heat produced by the first reaction ;[3] that, in addition, secondary reactions may manifest themselves and finally that the phenomena are certainly influenced by the temperature, degree of purity of the materials, etc.

Free Gold.

Prof. Liversidge, in a recent paper read before the Royal Society of New South Wales, estimates the total amount of gold dissolved in the water of the ocean at 100,000,000,000 tons. As the ocean belongs to no one, this fortune can be had by any one who will go and get it ; electrochemists stand the best chance.

[1] *Moniteur Industriel*, 1885. *Bulletin de la Société Chimique de Paris*. 1887 Vol. 1. p. 86.

[2] Dr D. Tommasi—Electrolyse de l'eau avec des Electrodes de differente nature (Comptes de l'Académie des Sciences de Paris, 1881).

[3] Traité théorique et pratique d'électrochimie, by Dr. Tommasi, p. 515.

The Electric Yacht "Utopian."

THE electric launch *Utopian*, built for Mr. John Jacob Astor in the shipyard of Samuel Ayers. at Upper Nyack, N. Y.,and launched on Sept. 10, is the largest and most handsomely appointed craft of her kind. The boat is now resting at Rhinecliff, the home of Mr. Astor, and will ply in Newport waters next Summer. The designer was Charles D. Mosher, of New York City.

The dimensions of the boat are as follows: Length over all, 72 feet; beam, 12 feet; draft, 4 feet. She is fitted with twin screws 34 inches in diameter, each having three blades. They are cast from a special composition metal. The stern of the boat, as will be seen from the sectional view in Fig. 5, is of a peculiar shape, a sharp heel terminating the sloping bottom at the water line. The screws are, therefore, directly under the boat and in spite of their high speed encounter solid water all the time. The boat is fully rigged, and has two hinged masts which can be removed at pleasure. It carries a foresail, mainsail and jib. The tender rests normally on the top of the hurricane deck, and is swung into the water by means of Mallory davits. The cabin is divided as follows: Beginning aft, there is the aft cockpit and the crew's quarters, in which is the centreboard; then comes a small gangway, on one side of which are toilet rooms and on the other the kitchen. Then comes the main saloon, under the flooring of which are the motors. Then the forward saloon, which includes the second centreboard, and then the forward cockpit, from which location the boat is controlled.

The boat is finished in polished oak, and has pneumatic cushions in the seats which serve as life preservers. The centreboard slot has leaves on either side, which can be swung up and serve as a table, both in the crew's quarters and in the forward saloon. The seats are arranged to be swung over and formed into beds if desirable.

The electrical machinery, of course, possesses greater interest to the reader. The power is primarily stored in two separate sets of accumulators, one for each motor. These accumulators are entirely independent of each other and are controlled each by an independent controller. Each set is divided into six sections and each section contains 32 cells, which are coupled in multiple, making a battery of 32 volts. These six batteries are connected in various ways to give the different speeds. There are 408 cells in all, each having a rated capacity of 300 ampere-hours. Fifty amperes is considered a safe charging rate. The storage batteries were supplied by the Samuels Dynamic Accumulator Company, of New York, and differ in their internal construction from any now extant. No grids are used nor is any lead nucleus present.

The positive plate, which, of course, is the essential feature, is a solid piece of active material, which, by means of a peculiar chemical construction is as hard and dense as a block of marble and becomes harder and more dense with age. Thus it is claimed the cell rather improves than deteriorates with use. To look at the plate one could imagine that it would be a good material to wind a switch upon on account of its insulating properties, but as a matter of fact it is highly conducting, and the internal resistance of these cells is extremely low. One of these solid plates of active material is formed in fourteen hours and the process is said to be very cheap. Twenty-six pounds of active material suffice for a 300-ampere cell of 11 plates, such as are used on the Astor boat The weight of each cell is 50 pounds. The cells on the Astor boat are carefully provided against slopping by having an extraordinarily deep case, the top of it being at least four inches above the water line. The output of these cells is controlled and delivered to the motors by means of two cylinder controllers, with fingers in a somewhat similar way to the ordinary street-car controller. Each cylinder is worked by a hand wheel, which is geared to the controller spindle. No reversing switches are used, the action being simply that a turn of the wheel in one direction gives speed ahead and reversing the motion of the wheel reverses the motor. There are eight speeds ahead and four astern. They are obtained as follows:

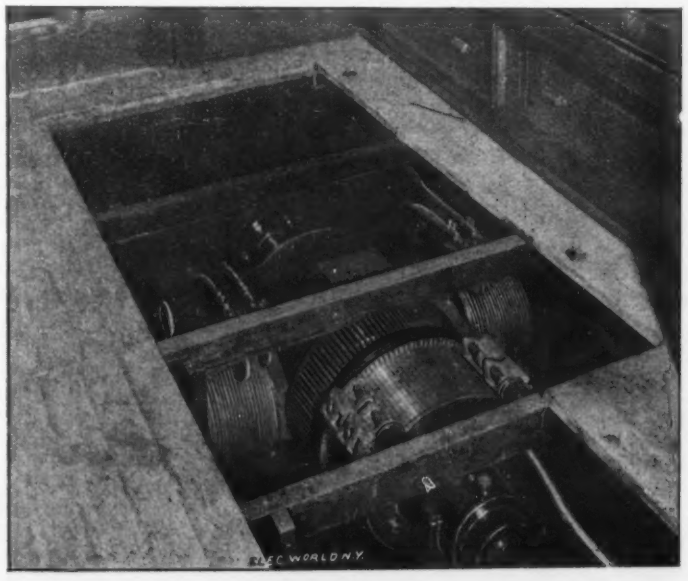


FIG. 1.—ONE OF THE MOTORS.

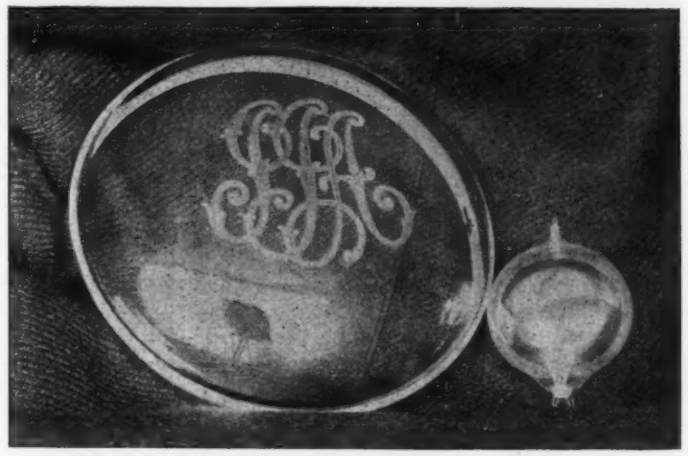


FIG. 3.—HURRICANE DECK CONTROLLING APPARATUS.

The fields of the motor are arranged to connect either in series or in multiple with each other; they are in series with the motor armature. In the first combination the voltage is 34 with the fields in series, and the second combination has the same voltage with the fields in multiple. These two speeds are also used astern. The next two combinations are with 68 volts with the fields in series and multiple. The next two are at 102 volts with the fields in series and multiple, the sixth speed also being a backward running. The last two speeds are at 204 volts with the fields in series and multiple, the last speed of all being available for backward running. Two amme-

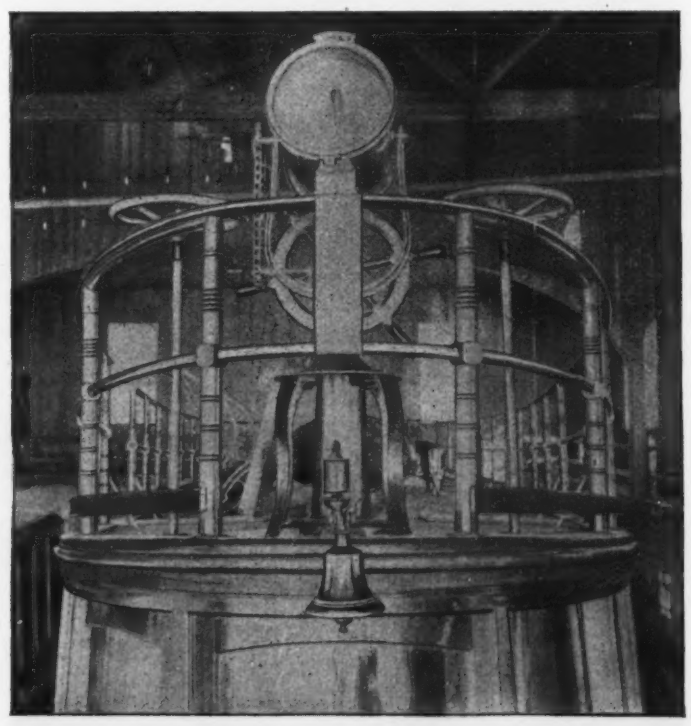


FIG. 2.—LAMP AND REFLECTOR.

ters and two voltmeters are placed on a little table in front of the controlling wheels and are always under the eye of the person in charge. The boat can be controlled either from the forward cock-pit as already stated, or from the hurricane deck above.

A Rushmore 1200-cp searchlight is placed on the hurricane deck directly in front of the controlling position and can be operated either from there or from below. It takes six amperes at 50 volts.

The motors were built by the Riker Motor Company, Brooklyn, and can continuously develop 25 brake horse-power. One of them is shown in Fig. 1, and in Fig. 5 their position with respect to the screws may be seen. The motors take 100 amperes at 200 volts. The fields are of steel, and as will be seen in Fig. 1, are extremely

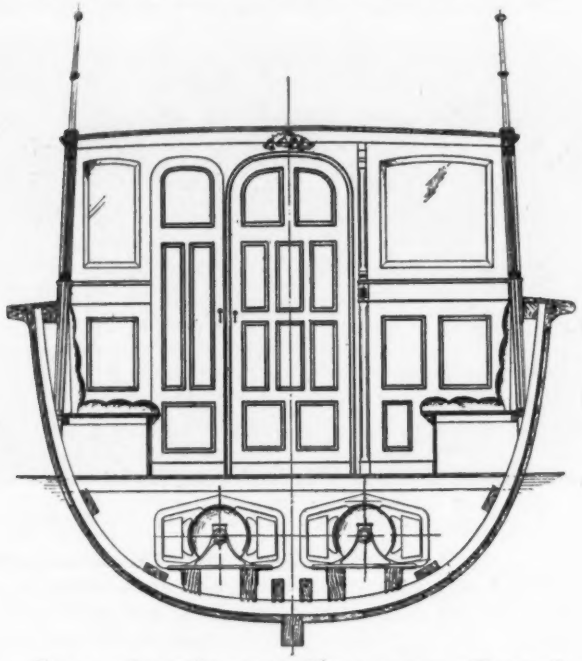


Fig. 4.—Cross-Sectional View of the "Utopia."

light. The armature is very large, thus insuring a good torque, and is barrel-wound with formed coils, and has a two-circuit wave winding. The speed is 1000 revolutions per minute and the guaranteed efficiency is 85 per cent. The weight is 1168 pounds and it is guaranteed to carry an overload of 100 per cent for four hours. The commutator, it will be noticed, is extremely large and substantial and the brushes are at right angles to each other and in a position convenient for their adjustment or renewal by simply lifting a trap door. Fig. 1 shows a view of the motor through the trap door of the boat and will assist in giving an idea of its arrangement therein. In Fig. 4, a cross-sectional view of the boat, the relative positions of the two motors can be seen.

Besides the propelling motors there is a capstan motor which will take 10 amperes at 110 volts. It is geared to the capstan by friction gearing in the ratio of 60 to 1 and will haul up the anchor under almost any conditions. This motor also runs the air pump which compresses air at 150 pounds to the square inch to blow the whistle. The whistle consists of three separate parts of different tones, which can be blown singly or all at once. Signals are exchanged between the engineer's station and the crew by means of 14 push-buttons in the engine room and a 14-drop annunciator in the crew's quarters.

The boat is lighted by peculiarly shaped lamps, each of 180 volts and 20 candle-power. They are somewhat similar in dimensions to a watch, and are suspended from their terminals and a third point in a hemispherical reflector covered with a glass crystal, on which is the monogram J. J. A. Fig. 2 gives an idea of this arrangement.

Fig. 3 shows the hurricane deck controlling station as taken from the extreme bow of the boat.

The total driving equipment weighs only a little less than 23,000 pounds, and compares favorably with that of the engine and boiler, and the freedom from smoke, coal and dust and other annoying but necessary features of a steam equipment are eliminated, thereby largely increasing the space available for other purposes. The speed expected from the boat is more than 16 miles per hour.

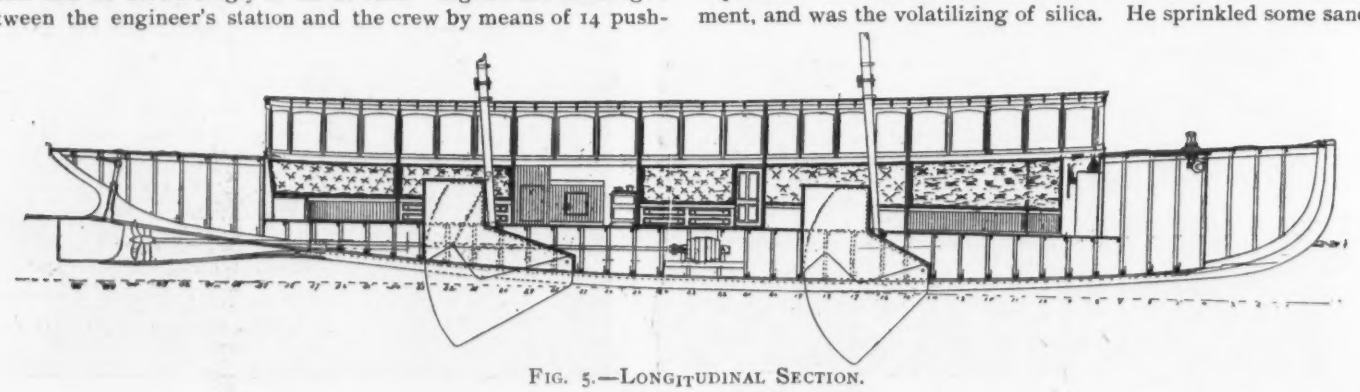


Fig. 5.—Longitudinal Section.

Lecture by M. Henri Moissan.

M. Henri Moissan, of the Institute of France and of the Académie des Sciences, who was a delegate to the Princeton sesquicentennial celebration, by invitation of the New York Academy of Science, New York Section of the American Chemical Society, American Institute of Electrical Engineers, College of Pharmacy of the City of New York, and the New York Section of the Society of Chemical Industry, on the evening of Oct. 27 delivered a lecture with experiments on his researches with the electric furnace. The lecture took place in the hall of the College of Physicians and Surgeons, on Fifty-ninth Street, New York City, and was attended by a large and representative audience. Although he spoke in the French language a great many of those present understood him, and even to those who did not there was great interest in following the speaker's movements.

M. Moissan explained that in his endeavors to obtain pure carbon he had found it necessary to use very high temperatures and had succeeded in obtaining one form of pure carbon, graphite. High temperature alone, however, would not yield a crystallized form of carbon, diamond. In his researches to find out the composition of diamonds he found iron. As cast iron decreases in volume in passing from the liquid to the solid state, he was led to believe that if an element of carbon were enclosed in a globule of cast iron that was cooling it would be subjected to the requisite pressure. He then performed the experiment of producing diamonds by means of an electric furnace erected on the stand. He first sprinkled the cavity in the chalk block, which together with large carbon electrodes constituted the electric furnace, with magnesia in order to prevent the formation of calcium carbide. After placing in a crucible some soft filings of cast iron and charcoal, the whole was inserted in the cavity, covered with a block of chalk and the current turned on. At the end of 10 minutes the current was interrupted and M. Moissan withdrew from the furnace the crucible, which was then at a white heat and a mass of flame. This he dropped into cold water. On breaking the crucible he took out a small ingot of iron and explained that the crystallized carbon was probably within the mass. The diamonds, he stated, had no commercial value as the largest he had succeeded in making thus far were not more than one millimetre in diameter.

He then gave some interesting facts regarding diamonds of different kinds and the effect in their artificial production of using different materials for the purpose of cooling the crucible.

The remainder of the lecture was devoted to a brief review of other products obtained by means of the electric furnace. The last experiment of Prof. Moissan illustrated his latest scientific achievement, and was the volatilizing of silica. He sprinkled some sand in the crucible, which in turn was placed in the furnace, and over the cover of the furnace was placed a glass bell, which caught the violet gas as it escaped through a hole in the furnace cover. The interior surface of the bell jar was coated with a film of an opalescent hue, produced by the condensed gases.

How to Increase the Working Efficiency of Railway Motors.

BY WM. BAXTER, JR.

The first workers in the electric railway field did not have as easy a task in the matter of designing motors as the engineers of the present time. Then electricity was endeavoring to obtain a foothold, so that it was necessary to meet the existing conditions and develop machines that would operate successfully under them, but in the course of a few years electricity obtained such mastery over the field that the designers were able to make such changes in the conditions as they found necessary to facilitate their work.

The old horse cars ran on 30-inch wheels, and the under side of the body was not over 12 inches above the centre of the axle, and in this space the motors must be placed. The speed of these cars was not over six miles per hour, and while greater velocity was desired, anything over 14 or 15 miles would have been regarded as inadmissible. On account of these restrictions, the difficulty of designing a single-reduction motor was more than those engaged in the work could overcome, hence the double-reduction machines were resorted to.

As soon as the popularity of electricity became demonstrated, engineers began to study the subject with a view to devising a single-reduction motor of reasonable weight and size and capable of running at a velocity not greater than that of the double-reduction motors. As the problem was a difficult one, they did not meet with immediate success. In the meantime electricity was forging ahead so fast that it soon became evident that a single reduction motor would be accepted even if it were a great deal heavier and larger than the machines in use, and even if it ran at a much higher velocity, providing it would reduce the cost of repairs, and this it was very evident it would do by greatly reducing the wear of the gearing, which at that time was a formidable expense. Taking this view of the case, no doubt, the larger corporations brought out single-reduction motors, which, from an engineering point, were but little short of failures. Their weight ranged from 3000 to 3500 pounds, and their size was such that they could not be used with safety on cars provided with 30-inch wheels; and the speed was increased from about 14 to 20 or 22 miles per hour. Not only were the wheels increased from 30 to 33 inches, but the car body was raised from two to three inches higher above theaxle, and therefore the distance from the under side of the car to the track was increased from 27inches to about 31. Notwithstanding the increase in size and weight, the cross-section of the field was so small that the torque was very much less for the same current than with the double-reduction machines.

By a series of steps the design has been improved, and as a result the modern motors are of a greatly reduced size and weight, in some cases weighing less than 1500 pounds, but the size of car wheels still remains the same, and is indeed necessary, owing to the fact that the gears on the axle are larger than could be safely used with smaller wheels. The current consumption has not been reduced to any appreciable extent, saving in this direction having been sacrificed, apparently, to obtain reduction in weight. Some of the engineers engaged in this field justify this course by saying that current is about the cheapest thing around an electric railway plant, and tha a few amperes, more or less, make very little difference. If this is sound reasoning, one must naturally wonder why so much money is spent in expensive compound and triple expansion engines, whose only advantage is that they reduce the cost of the output.

It is evident that a reduction in the current consumption is of the greatest importance, for it not only reduces the running expenses, but also the first cost of the plant. If a saving of 20 per cent. in the average current consumption per car can be effected, the station and line capacity can be reduced to that extent, and the cost of this part of the plant would be no greater for a 100-car road than it now is for 80 cars.

Engineers who have never had experience in designing railway apparatus are very apt to believe that if the efficiency of the motors is high, any such saving as 20 per cent. is impossible, but this is not the case, and it will be shown that it is not in the following paragraphs:

Some time ago a brief description of one of the latest motors brought out by the General Electric Company appeared in the columns of THE ELECTRICAL WORLD[1]. Curves were given showing the horizontal effort, the speed and the efficiency, and the latter was shown to be nearly as high as 83 per cent., with a current of 40 amperes to the car, and not lower than 74 per cent. within the ordinary working range. This efficiency is certainly very good, for it must be remembered that it includes the loss due to the friction of the gears and all other parts ; but a study of the horizontal effort curve will show that the increase with increasing currents is not as great as it might be. As an illustration, take the efforts at 20, 40 and 80 amperes, which are as near as can be judged from the curve 180, 350 and 1380 pounds, respectively. Now, as the frictional loss is a greater percentage of the lower efforts than of the higher, the difference in the torques would not be as great as these figures, but would probably be 200, 600 and 1500. If the field remained constant the torque would rise in direct proportion with the current, and owing to the reduced frictional loss the horizontal effort at 40 amperes would be more than double that of 20, that is more than 360 pounds, probably 380. As at the low rate of magnetization that must prevail with such a small current the greater part of the magnetizing force is impressed upon the air gap, the increase in the flux density should be nearly proportional to the increase in current, and therefore the effort at 40 amperes should be not far from four times as great as at 20. At 80 amperes the effort is about 1380 pounds, which is not as great an increase in proportion as that between 180 and 550, but this is the natural result of the greater magnetic density. These figures indicate that the cross-section of the field is not as great as it should be to obtain the necessary flux with a low magnetizing force, and that the deficiency in this direction is made up by an increase in the ampere-turns, It is believed by some that this principle of proportioning is the correct one, and in defence of it they point out the fact that if the cross-section is increased and the magnetizing force is reduced, the effect will be to cause the speed to drop too much when the current is increased, and they contend that it is better to use a little more current and keep up the velocity. If the difference in velocity were as great as the difference in current, and if all thi difference could be made available, the argument would be a good one; but the gain in speed is effected at a very heavy current expenditure, and on this account motors having a large field cross-section

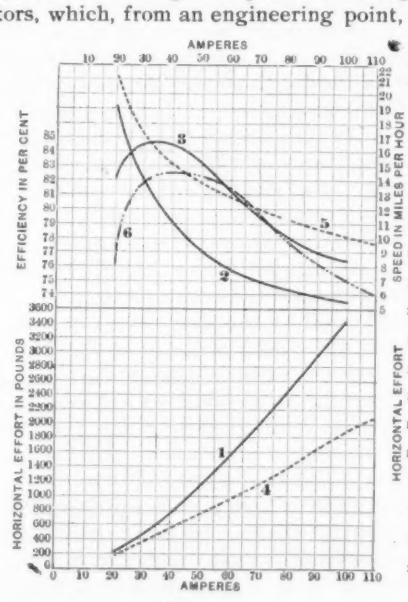


FIG. 1.

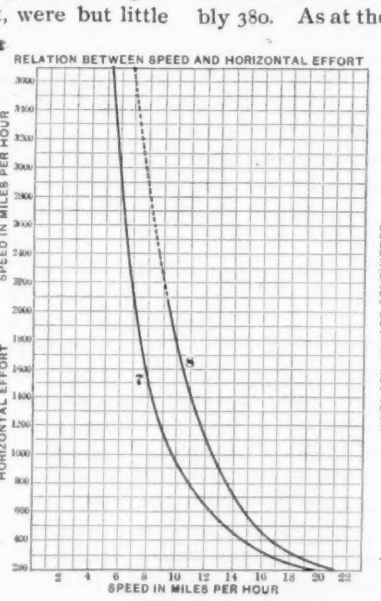


FIG. 2.

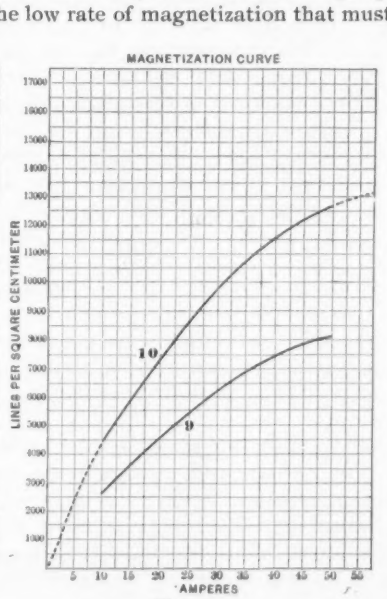


FIG. 3.

[1] Aug. 8, 1896, page 176.

and a sufficient number of turns on the armature to cut down the velocity with respect to the current, will run the car at very nearly the same speed against a given resistance, owing to the fact that the necessary effort can be obtained with less current; therefore, the working velocity will not be reduced very much, but the current will. Furthermore, as the large field motors can develop a greater torque with excessive currents, the rate of acceleration in starting will be greater, and time will be saved in this way. Adding to this the fact that running speed does not help much to increase the velocity through crowded streets, and that going down grade the fast running cars cannot gain much, as the velocity is such that the current is cut down to a point where the effect of it is slight, it must be evident that for the general run of city and suburban roads, increased motor speed is of very little advantage in the way of enabling the cars to make better time from end to end of road, and that its real effect is to considerably increase the current consumption.

Purely theoretical reasoning is seldom as convincing as an actual demonstration, based upon practical results, therefore the writer may be pardoned for presenting in the following the operation of motors of his own design in which the principles above referred to were adopted.

The curves 1, 2 and 3 in Fig. 1 show the horizontal effort, speed and efficiency, respectively, of a car equipment of two motors. The dotted curves 4, 5 and 6 give the corresponding data for the G. E.-1000 motors just considered. The table gives the data of Fig. 1 more accurately than it can be obtained from the latter, and in addition to this the electrical and effective horse-power. The field cross-section of these motors ranges from 695 sq. cm in the armature core, to over 800 in the largest parts of the field proper. The air gap area is about 1100 sq. cm; length of magnetic circuit, 48 cm; turns on field 200; turns on 1015 equal 507 in series; air gap 6. 4 mm.

A comparison of curves 3 and 6 will show that the difference in the efficiencies of the two types of motors is very slight, and that where the current runs from about 57 to 70 amperes, the dotted curve is the higher. The difference in the horizontal effort curves, however, is very great. At 20, 40 and 80 amperes, the figures are: 215, 765 and 2480 pounds for the solid line and 180, 550 and 1380 for the dotted. The increase in the effort of the dotted line between 20 and 40 amperes, is in about the ratio of 3 to 1 and for the solid line about 3.5 to 1. Between 40 and 80 amperes it is about 2.7 to 1 in the former case, and 3.25 to 1 in the latter. In the dotted line curve the increase between 40 and 80 amperes is about 90 per cent. of what it is between 20 and 40, but in the solid curve it is 93 per cent. From this we can see that for the first doubling of the current the increase in horizontal effort is less in proportion in the dotted curve than in the solid one, and that in the second doubling it is still less. This shows that the magnetization is higher for a given current with the motors represented by the dotted curve than it is in those represented by the solid line.

The difference in the efficiency of the two motors is the natural result of the greater field cross section. In the solid curve the maximum is reached between 30 and 35 amperes, and in the other at about 45. The explanation of this is that the proportion of the torque that is neutralized by the friction is very nearly the same in both cases, but as the large field motors give a higher torque with the same current, this proportion becomes a smaller percentage of the power developed in the case of the latter motors, hence the point of maximum efficiency is carried back to a lower current. The change in the relation of the efficiencies for currents between 60 and 70 amperes is not so easily accounted for, except upon the assumption that mistakes were made in the tests, in either or both cases, an occurrence that is possible even under the most favorable conditions. Beyond the 70 ampere point the efficiency of the solid line curve diverges rapidly from the other, which shows that the large field section increases the efficiency with large currents, a natural consequence of the lower magnetic density.

An examination of the speed curves 2 and 5 will show that with equal currents the large field cross-section runs very much slower, and the difference increases rapidly as the current increases; thus with 20 amperes the speeds are about 19.2 and 21.3 miles, which is a difference of close to 9 per cent, but at 60 amperes the velocities become 7.85 and 12 8 miles, the difference between which is about 37 per cent. This increased reduction in speed is due to the fact that the small cross-section fields with high magnetizing force soon become magnetized to a point where the permeability is so low that the increase in magnetizing force due to increase in current produces only a small change in the flux. On the other hand, the large field cross-section, with the same current, is magnetized to a lower density, owing to the reduced number of ampere-turns, This is clearly shown in Fig. 3, which gives in curve 9 the density in the air gap, and in curve 10, that through the armature core.

Although the velocities with equal currents are widely different with the two types of motors, when the relation between speed and horizontal effort is looked into it will be found that the difference is very much less. This is shown in Fig. 2, in which curve 7 gives the speeds corresponding to different efforts, for the large field motors, and curve 8 the same for the small field. Here we see that with a horizontal effort of 400 pounds the speed of the two motors is 14.6 and 16.8, but the current consumption is about 27 amperes for the slow speed and 37 for the high. The difference in speed is about 15 per cent., and to obtain this the current is increased about 37 per cent. With higher horizontal efforts the difference between speed and current becomes still greater. At an effort of 2000 pounds the speeds are about 7.2 and 9.6, while the currents are about 70 and 105 amperes respectively. The increase in speed is about 33.5 per cent. and the increase in current about 50 per cent.

From the foregoing it must be evident that to reduce the field cross-section so as to obtain higher velocity with larger efforts is not a wise course to pursue, since the increase is obtained only by the expenditure of an unreasonable amount of energy. If high-speed motors are desired, as for interurban roads, the best way to make them is with a low magnetizing force and a sufficiently small number of armature turns to obtain the required velocity with a field of as large cross-section as can be obtained conveniently. Such construction will give higher efficiency at all speeds for the same reasons that it does in generators and stationary motors. What the points here brought out show more clearly than anything else is that it is not advantageous to use motors that are designed to give a comparatively high speed when working against a high resistance for city and suburban roads. With such a construction the maximum effort is very much lower than that of motors which will slow down more, therefore the current required to start will be greater and more time will be lost in getting under headway, as the rate of acceleration will be slower.

High-speed motors, even if made with large field cross-section, are not the best for roads where there is much stopping to be done. Steam-railway men long ago found out that very little could be gained in the running time of local trains by using high-speed locomotives, because the time lost in making stops is very nearly the same in any case, and the runs are so short that the benefit of the greater velocity cannot be utilized to any great extent. This is equally true of electric roads where frequent stops are made, and it is demonstrated practically by the record of the old double reduction motors, which would run on a level track at about 14 miles per hour, or at about two thirds of the speed of modern cars, but with all this difference, the average running time was very little lower than at present.

Motors that would give a speed of 15 miles with 25 amperes and an horizontal effort of 3000 pounds with less than 100, would make practically as good time as the motors now used, and would reduce the current consumption from 15 to 20 per cent.

TABLE OF CURRENT, HORIZONTAL EFFORT, SPEED, POWER AND EFFICIENCY.

E. M. F.	Amperes.	Horizontal Efforts. Lbs.	Electrical H. P.	H. P. on Track.	Speed. Miles per Hour.	Working Efficiency. Per Cent.
500 Volts.	20	215	13 40	11.00	19.20	82
	30	450	20.10	17.00	14.00	84.6
	40	765	26 80	22.60	11.10	84.4
	50	1145	33.50	27 80	9.10	83.3
	60	1570	40 20	32.70	7.85	81.6
	70	2000	46.90	37.30	7 00	79.6
	80	2480	53.60	41.90	6.40	78 2
	90	2940	60.30	46.70	5.95	77.2
	100	3460	67.00	51.20	5.55	76.4

A Peculiar Property of Fluorescent Bodies.

In a paper read before the British Association meeting Mr. John Burke stated that he had determined, with the aid of a double-slit photometer and also photographically, that fluorescent bodies such as uranium glass absorb more light when fluorescing than when not. Uranium glass is therefore less transparent to the light of the candle in the daylight than it is in the dark. In other words, the absorption coefficients are altered during the fluorescence for the particular rays the bodies emit.

Experiments on the Theory of Telephonic Sound.

BY RIUJI NAKAYAMA.

INTRODUCTION.

The action of the telephone transmitter and receiver is the transformation of the vibrations of air into the pulsations of electrical current, or the transformation of the pulsations of electrical current into the vibrations of air. In order to obtain a complete understanding of the subject investigation must be made both from the point of electricity and from the point of acoustics. Heretofore, so far as I can learn, investigations and papers published by different authorities have been almost entirely from the electrical point of view, and much is left to be learned from the point of acoustics.

The purpose of my investigation has been primarily to understand the action of the transmitter and receiver from the acoustic point of view, in order to clearly define the relation of the diaphragm to telephonic sound, and secondly to understand the properties of telephonic sound. It is very important to the telephonist to know what sounds are most difficult to transmit and what sounds are most easily misunderstood, but these subjects have heretofore been left untouched; hence the second part of my experiment was to determine these things, and to find the reason why telephonic sounds are indistinct and why certain sounds are most difficult to transmit or easily misunderstood. The third object of my experiments was to find the requisites of a good transmitter.

The telephonic circuit consists of three parts, the transmitter, receiver and line. In the three parts are transformation and dissipation of energy, so that we must investigate the subject from three points of view. The action of the induction coil, self-induction, static capacity and leakage in the line belong to the electrical part. My experience has been chiefly with the transmitting part and receiving part.

As my experiments were carried on in the Japanese language, the details of the results will be different from those of the English language. For example, *s* and *z* in English are the most difficult to transmit by telephone on account of their sibilant sound, but in the Japanese they are not so sibilant as in English and hence not so difficult to reproduce. So, some will think that this paper is of comparatively little interest to English readers; on second thought they will find that although some of the minor details of the experiments are peculiar to Japanese and are different from English, yet the principles and the properties of the telephonic sound, if properly defined, must be universal and common to every language, and that we may extend the results not only to the English language but to any other. This is my reason for presenting this paper to them.

The paper is divided into four parts, viz.: I. Properties of Human Speech; II. Experiments; III. Conclusion; IV. The Ideal Transmitter.

I. PROPERTIES OF HUMAN SPEECH.

Human speech is produced by forcing air from the lungs through the windpipe, where it may or may not set in vibration the two elastic membranes of the larynx called the vocal cords. In the first case voice is produced. When the vocal cords are not set in vibration we have what is called flatus or wind rush.

After passing the larynx the voice, or flatus, either enters the mouth, the form of which, varied by the tongue, lips or teeth, modifies the sound by its resonance, etc., or nose, when entrance to the same is not prevented by the pressure of the uvula against the back of the pharynx, thus greatly modifying the sound by the vibration of the complicated membranes which line the nasal passages. When the sound passes through both the mouth and the nose we have sounds corresponding to the French nasal vowels, viz.: *au*, *ou*, etc.

Properties of Vowels.—The simplest sounds of human speech are *a e i o u*, the five vowels. These are produced in a simple manner, that is by opening the mouth and breathing. So that by narrowing or widening the mouth we may pronounce all the vowels.

Human speech, though greatly varied in form, all comes from the vowels (commonly five). This has long been known, but is set forth theoretically by Helmholtz. The following is an extract from his "Theory of Vowels": He says that the difference between the vowels is simply due to the difference of quality; that the quality of vowels is their characteristic, and quite independent of the fundamental tone by which they are pronounced; and that the difference of quality is the different resonance of the mouth in pronouncing certain vowels. In other words, we can produce *a* or *i* or *u* in the same note, and the only way by which we distinguish them is the relative difference of wave form. He clearly explains this as follows: "A vowel is nothing more than the particular timbre taken by any note, if the resonance of the mouth strengthens amongst the harmonics of the note that which approaches nearest to a certain note." The characteristic of vowels is certain harmonics resonated by the mouth, whatever their fundamental tone may be. Thus when we pronounce *a*, the harmonics which have a vibration of 932 per second are always resonated, and when we pronounce *o*, the harmonics having 466 vibrations per second are resonated, and when we pronounce *u*, the harmonics having 175 vibrations per second are resonated, and so on. Hence to pronounce a certain vowel we must shape our mouths so as to resonate certain harmonics, which characterize the vowels. If we open our mouths widely and pronounce naturally, we can pronounce no vowel but *a*, and so on. Helmholtz proved this theory with his resonator, by means of which he is able to imitate vowels or to decompose them.

A consonant is very complicated compared with vowels. The formation of vowels chiefly depends upon the width of the inside of the mouth, while if we add the motion of the lips, teeth, tongue or palate and obstruct or stop the passage of air at the beginning or at the ending of pronunciation, the consonants are formed. In short, the vowels are characterized by the width of the inside of the mouth, while consonants are characterized by stoppages or obstruction of the passage of air at the beginning or at the ending of vowels.

Japanese Syllabary.—As my experiments were carried on in the Japanese language, it is necessary to explain a little about it. The Japanese letters were originally derived from the Chinese characters. These characters are used phonetically, each standing for a sound of a Japanese syllable, consequently they took the syllable instead of the alphabetic form. The Japanese syllabic consists of five vowels, two semi-vowels, and twelve consonants. The vowels are *a*, *e*, *i*, *o*, *u*, the semi-vowels *w*, *y*. There are seven pure consonants, i. e., *H*, *K*, *M*, *N*, *R*, *S*, *T*, and four impure, *B*, *D*, *G*, *Z*, and one partial impure, *P*. Putting these semi-vowels and consonants before each vowel gives us 70 syllables. Besides these syllables we have *N*, thus making a syllabary of 76 sounds.

II.—EXPERIMENTS.

These experiments were made by having 25 different persons take turns at receiving and transmitting. They pronounced each letter or syllable three times, and did not take them in regular rotation. The person at the receiving end wrote down the sounds as they sounded. There were 20 women and five men. They were all familiar with the telephone, having had from one to five years' experience in its use. In these experiments the women operators were found to be much quicker in catching the sounds than the men.

In the first experiment they used the ordinary American 80-ohm receiver and Blake transmitter. During the course of the experiment the receiver and transmitter were each changed frequently, in order to eliminate any errors in the instruments.

Every person transmitting spoke the entire 75 syllables, and the following tables are the result of each syllable being spoken and received at least 200 times by different persons during the course of the experiments.

A few long-distance transmitters were available, but uncertainty as to their proper adjustment caused an indefinite postponement of experiments with them.

We can sum up the results as follows:

(1) The telephonic transmission of sound is subject to the similar modifications as in air when two men converse at a distance. The similar sounds, as *m* and *b*, *t* and *d* become firstly indistinct. Later, all syllables containing the same vowels, such as *me* and *be* become confused, and finally, only the leading vowels can be understood. No consonants can be transmitted as clearly as vowels.

(2) The vowels and semi-vowel sounds (*y* and *w*) are the clearest.

The pure sounds rank next.

The partially impure and impure sounds are most frequently misunderstood. The mean average for the percentage of clearness was found to be as follows:

For semi-vowels and vowels—69 per cent.

For pure syllables—40 per cent.

For impure and partially pure—20 per cent.

When classifying by syllables containing one of the several vowels—38 per cent.

(3) Thirty out of the 75 syllables are understood by the average telephone operator.

Eleven out of the 75 are always understood somewhat imperfectly.

Thirty-four out of the 75 are not understood at all, even by ordinary telephone operators.

(4) When one first listens to a telephone he will understand all the syllables as their leading vowels. Only vowel sound in any syllable is clear, so that it seems as the vowel sound alone ; so it is hard to distinguish between different syllables having the same vowel.

(5) Clear sounds are *yo, wo, yu, ya, wa, a, i, u, e.* These sounds are generally distinct to persons who are not well accustomed to using a telephone.

(6) The impure sounds; that is, syllables beginning with the sounds of *g, z, d, b* and *p*, are most difficult to understand. An experienced operator can only understand 20 per cent. of these sounds.

(7) The following syllables are easily misunderstood:

Impure sounds similar to each other; syllables beginning with the sounds of *d, z* and *r; t, k* and *p; s* and *h; m* and *n; m, w* and *b;* similar to each other in their respective groups.

Impure sounds are similar to the corresponding pure sounds; as *k* for *g, t* for *d.*

III.—CONCLUSION.

(*a*) Principal cause which renders telephonic sound indistinct: The first conclusion in the foregoing summary is sufficient to show what is the principal cause which renders the telephonic sound indistinct. From the properties of human speech, we see that the difference between two sounds or syllables of similar articulation is a very small part of the wave form, characterized by small waves or noise. These small waves are apt to be destroyed, and are very difficult to transmit, even in air. If the small waves are partially destroyed, then their general wave forms become more nearly alike, if not identical. Thus it was well known that in speaking to a person at a distance, the sound being carried by the air, the consonants of similar articulation (such as *m* and *b* or *d* and *n*), first become indistinct; after that all consonants become indistinct and the vowels remain most clearly heard, because they are not characterized by small waves.

Now, in transmitting these sound-waves by telephone the small waves are destroyed and lost by the inertia of the diaphragm ; in short, these small waves are not strong enough to overcome the inertia of the diaphragm to give it a corresponding motion. Thus the waves' forms are modified and become more and more alike, and the sounds of nearly the same articulation are the first to become indistinct.

The sounds of different articulation differ widely in comparison with sounds of similar articulation; hence their wave forms are not so liable to be mistaken for each other, although they are not as distinct in telephony as when transmitted verbally.

All syllables containing the same vowels have the same fundamental wave form, the only difference being the wave forms which characterize the consonants. If the small waves are destroyed by the inertia of the diaphragm, the wave forms will become similar to each other, and finally will take the wave forms very similar to the leading vowels.

In other words, small waves are lost by the inertia of the diaphragm, which causes the sound waves to resemble each other so closely that to distinguish the difference between one word and another requires an ear made sensitive by practice.

The vibration of the diaphragm under the influence of sound-waves may be likened to the motion of a ship on water. For short, choppy waves the ship would have so much inertia that it would not move, but for a long, heavy swell the ship would rise and fall with the wave-form. The motion of the diaphragm is like that of the ship in the water, and if the wave of air is strong enough to overcome the inertia of the diaphragm, then the diaphragm will make a vibration corresponding to the aerial vibration. But if the aerial vibration is so small and so rapid that the diaphragm on account of its inertia cannot make vibration corresponding to the air wave, then the diaphragm cannot transmit the sound-wave perfectly. This is the reason why the vowels are transmitted so much better than the consonants; the consonants pronounced in the same way are very indistinct, and all syllables containing the same vowel are difficult to understand and also easily misunderstood as its vowel by inexperienced persons.

To explain the foregoing summary, attention is called to the following points: (Referring to Summary No. 2.)

The vowels and semi-vowels are most distinct because they are not characterized by small waves, as is the case with consonants.

Consonants are characterized by small waves or noise, so that they are very liable to be destroyed by inertia of the diaphragm before it responds.

The impure and partially impure sounds are explosive, and much more characterized by very small waves, which are easily destroyed at the beginning of pronounciation.

Gi, zi, di are explosive sounds and also characterized by small waves at the beginning, which are destroyed, and then the sound becomes very similar to *i.*

Why syllables beginning with *r* are clear is because *r* has a liquid sound very similar in property to vowels.

B, m and *w* are all lip sounds, so that the mode of articulation is very similar, and their wave forms are very much alike. The slight difference in the wave form makes them indistinguishable from each other.

The reason why the sounds of *d* and *z* are heard as *r*, is that *d* and *z* are dentals and pronounced by the teeth and tip of the tongue, while *r* is pronounced by the top of the tongue.

The sounds of *t, k* and *p* are similar, because they are all explosive consonants and belong to the same class, *tenues.*

The sounds of *s* and *h* are similar because they are fricative sounds and sibilant.

The sounds of *m* and *n* are similar because they are both nasal sounds.

K, t and *p* are very similar. The only difference is the time when the vibration of the vocal cords begin.

From the above explanation we infer that the principal cause of indistinctness in the telephonic sound is that the diaphragm cannot make vibrations corresponding to the small vibrations of the waves of sound.

Mr. Mercadier explains the principal cause of indistinctness of telephonic sounds as follows. (These conclusions are different from the results of my investigations.):

"Alteration of articulation of vowels consists, on the one hand, of the exaggerated predominance of certain consonants and vowels, and syllables, *p, b, r, k, a, o, an, on, ent,* and in the marked weakening of *l, s, c, z, i, e* and *u.* The consequence is that it is frequently very difficult to understand the meaning of a sentence, and to decipher the words distorted in this way. Hence a constant source of error."

(*b*) *Why We Do Not Find Difficulty in Telephoning.*—From the above experiments, the indistinctness of telephonic sound is quite astonishing, only 30 out of 75 syllables being understood, and 34 out of 75 being absolutely indistinguishable even for telephone operators. (Summary No. 3.) Yet in spite of this imperfect telephonic sound we did not find any difficulty in ordinary talking. Some authorities think it remarkable that the small waves are transmitted so clearly by such crude instruments, but I should say that it is marvelous that we can understand telephonic sound after it has been so deformed. The reason is that primarily the ear can be developed by the constant use of the telephone to understand imperfect sounds, and secondarily by anticipation of the details when the main subject matter is understood. Any of the human senses may be trained to great acuteness by necessity. For example, from necessity we are very accurate in distinguishing human features. When one goes to a foreign country, the people all look alike, and one cannot distinguish men from women. By acquaintance with them one's sight becomes more sensitive, more developed, and then one can distinguish men from women, but still cannot tell one man from another. Finally the eye becomes still further developed and one can distinguish individuals. The sensation of hearing is very susceptible to training. When a man first hears the sound of the telephone, he cannot distinguish the difference between sounds, but soon the hearing becomes developed and he can distinguish a slight difference between one word and another. In my experiments an operator with a year and a half experience with the telephone could understand 30 out of 75 syllables, while an operator who had been employed for two or three years could understand 44 out of 75.

From the context of the conversation one has an idea of what the sounds are going to be. As the sounds are similar to each other they are heard as expected. Thus if *ba* is transmitted it may be heard *ma* or *wa*, as expected ; so that the anticipation of the subject matter assists materially in understanding the telephonic sound.

(*c*) *Sympathetic Vibration of the Diaphragm.*—Every substance has its own vibrational number and its own mode of vibration, and if we give it a vibration corresponding to its number the effect is very noticeable. This is known as sympathic vibration in acoustics, and gives a very marked effect.

(*To be continued.*)

[1] Telephonic Reproduction of Speech. London *Electrician*, Vol. XXVI, p. 485.

A Direct-Reading Wheatstone Bridge.*

BY A. P. TROTTER.

In James Swinburne's "Practical Electrical Measurements" (1888), Major Cardew's "Lightning Conductor" bridge is described, and is followed by a modification arranged by Mr. Swinburne as "a simple bridge on an emergency or for amateurs."

"An evenly divided scale, divided into, say, 1000 parts, is mounted as shown in Fig. 1. A uniform wire is stretched over it from the binding screw E to N, returning by D and F to the other binding screw H. . . . The points E, K, M and H are fixed because they are determined by the design of the apparatus. The problem

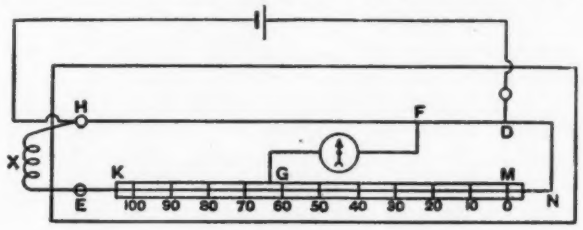


FIG. 1.

is to find the points F and D so that the bridge will read proportionally from M to K, and will read in ohms or tenths or hundredths." The mode of calibration is discussed at some length.

It is to be observed that, unlike the ordinary Kirchoff bridge, the ratio arms are $H\ D$ and $F\ D$, not $H\ F$ and $F\ D$. Part of the slide wire $G\ M$ is proportional to the unknown resistance + the remainder of the slide wire. In no books to which I have access can I discover the inventor of this mode of using a Kirchoff bridge. In the old mode two readings were taken, one from each end of the scale, and a ratio was obtained from which the unknown resistance could be calculated. This is far too cumbersome for practical use. I assume that this very valuable mode is due to Major Cardew. Mr. Swinburne suggests that more than one pair of points, F and D, may be found for more than one ratio. The form of bridge which is the subject of the present paper is derived from this suggestion.

The first modification is that the wire is not in one continuous length, but is arranged as in Prof. Cary Foster's mode of comparing two slide wires, and consists of two wires connected together at one end by a bar of negligible resistance. One of these wires constitutes the ratio arms, and the other is the slide wire. The former is concealed in the instrument. Ratio points are carefully found once for all, and branch wires are soldered at these points.

It does not appear, in Mr. Swinburne's book, that he recognized that if two separate wires and a low-resistance connecting piece be used, the zero of the scale of resistance on the slide wire is always to be found opposite the ratio point on the ratio wire. To take advantage of this disposition the scale of the present bridge is made to slide. This is the second modification.

Ratio points 1:1, 1:5, 1:10, 1:20 and 1:100 are determined, and the necessary branch wires are attached. The scale sliding in a groove is provided with a spring catch which holds it accurately in place, with the zero opposite to any desired ratio point. In order to avoid the idea of applying a ratio, the ratio points are described as 2, 10, 20, 40 or 200 "ohms maximum reading," the scale being divided from 0 to 20. This constitutes the third modification. The fourth modification, arising immediately from the last, is the utilization of

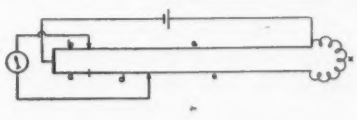


FIG. 2.

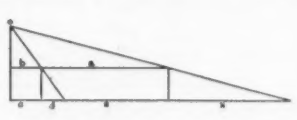


FIG. 3.

the spring catch for making contact between the ratio branch wire and the galvanometer. A galvanometer wire runs by the side of the slide wire, as in the Crompton potentiometer, and contact is made by the spring catch between this wire and the ratio branch wire.

Fig. 2 shows the connections. The whole arrangement has been reversed, in order that the scale may read from left to right.

The ratio wire is divided into two parts, a and b. The ratio is not a/b, but $(a+b)/b$. The slide wire is divided by the sliding contact into two parts, e and $c+d$. The portion d is a measure of the unknown resistance x. The portion c is beyond (to the left of) the zero of the scale, and is equal to b. Then

$$\frac{a+b}{b} = \frac{x+e+d+c}{c+d}.$$

Let the line $b\ a$ be divided into any two parts b and a. Draw the line $c\ d\ e\ x$ parallel to $b\ a$. Complete the right-angled triangles, as shown in Fig. 3. Then $\frac{a+b}{b} = \frac{x+e+d+c}{d+c}$, and since $b = c$ and the triangles are similar, $\frac{a+b}{b} = \frac{x}{d}$. For a $\frac{1}{10}$ ratio, b is $\frac{1}{10}$ of the whole wire $a+b$, and a is $\frac{9}{10}$.

Nickel steel wire is used. The strength, hardness, freedom from corrosion, high resistance and moderate temperature coefficient of this material make it peculiarly applicable for this purpose. It has been well tested and has been found very suitable for potentiometers. The arrangement of the bridge as described allows the terminals to be very conveniently arranged.

The details of the instrument have been worked out by Mr. W. C. Fisher, of Messrs. Crompton & Co. The wires are 15 inches long and have a resistance of 2 ohms each. The whole instrument is 1 foot 5 inches long, 2½ inches wide and 1¼ inches thick, including terminals. For low resistance the scale is pulled half way out, the maximum reading would be 2, but the two projects beyond the limits of the slider and the highest reading is 1 ohm. One division of the scale is equal to $\frac{1}{100}$ and this may be divided by the vernier. For high resistance the scale is pulled out 0.15 inch and the highest reading would be 200 ohms. This, however, projects beyond the limits and 198.5 ohms is the highest reading. One division of the

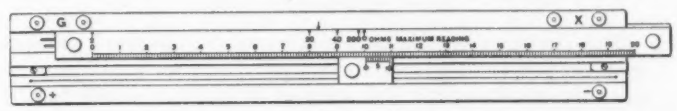


FIG. 4.

scale is equal to 1 ohm and may be divided by the vernier. It is hardly necessary to claim high accuracy for this instrument which is intended for general use and for measurements of the same character as those of current and pressure for which ordinary ammeters and voltmeters are used, to claim that it is at least more accurate than such instruments is perhaps not presumptuous.

* Extract of paper read before the British Association at Liverpool, Section A.

Atmospheric Electricity and Telephones.

An interesting paper by Trabert, on the crackling of the telephone on the Sonnblick, appears in the fourth report of the Sonnblick Verein, says *Science*. The Sonnblick, it may be stated, is one of the best known mountain observatories in the world by reason of its height (10,154 feet), and especially by reason of the valuable results which have been derived by Hann and others from the observations there made. For six years five observations a day have been made of the intensity of the crackling in the telephone at the summit. It appears from these data that in December the minimum crackling is at noon, with the maximum at 9 p. m., and a secondary maximum at 7 a. m., while in June there is a steady increase in the intensity of the noise from 7 a. m. to 9 p. m., without a noon minimum. The other months of Winter and Summer follow respectively the same rule as December and June, while the intermediate months, as expected, present the intermediate conditions. Further, the noise is greater in Summer than in Winter. Regarding the explanation of these phenomena, the author finds it chiefly in the presence of atmospheric electricity in the clouds over the Sonnblick, for there is a very striking correspondence between the crackling and the cloudiness of the summit, not only in the diurnal period, but in the annual as well. The days on which there is the greatest intensity of crackling are almost invariably distinguished by cloudiness, rain, snow or thunder storms. The part played by earth currents must not be overlooked, for on one cloudless anti-cyclonic day there was a very well-marked crackling, which could not be explained as being due to atmospheric electricity.

Money Well Spent.

The German Imperial Reichsanstalt cost originally $1,000,000 and involves a yearly expenditure of about $72,000 for its maintenance.

The Modern Power-House.*

BY RICHARD M'CULLOCH.

It may be readily seen that there are two standpoints from which the design of the power-house may be viewed. That of the one who strives that the general plan, that each machine and that every arrangement shall tend solely toward the cheapest possible production of power; and that of the other who, while appreciating the position of the former, desires also that nothing shall enter into the design which will materially effect either the simplicity or the reliability of the plant. The cost of power on a large road is about 10 per cent. of the total operating expenses, and it is almost a self-evident fact that the use of any apparatus which might produce unreliable service and thus impair the receipts and ruin the prestige of the road in order to save a small percentage of this cost of power would be very bad business policy.

As by far the greater number of the modern railway power-stations are operated by steam power, steam alone will be considered in this article. For convenience in discussion the apparatus in a power-station may be divided in three classes: (1) The steam-generating part, consisting of the boilers, pipes and all their accessories, such as coal and ash conveyors, mechanical stokers, stacks, economizers, feed-water heaters, pumps, etc. (2) The steam-consuming part, consisting of the engines, steam separators, oiling devices, condensers, etc. (3) The electric part, consisting of the dynamos, cables, switchboard, electrical instruments, etc. The division between the first and second parts is more easy and more marked, as it is usually accentuated in the power-house itself by means of a brick wall.

STEAM GENERATING APPARATUS.

The choice of fuel is largely a matter of location. In a general way the proper fuel to use is that which will evaporate the greatest quantity of water per dollar invested in it. It does not pay to burn a poor quality however, because slack containing a great quantity of ash and sulphur will cake and clinker on the grate bars, make a great deal of work for the firemen, refuse to be forced when necessary, and make much ash to be removed. On the other hand, it will not do to make all arrangements for using a very expensive fuel, as a very little wasted in times when the furnaces must be pushed, will make a great difference in the cost of operation. As an expensive fuel usually means one which is brought from a great distance, any furnace prepared for burning this would operate under unfavorable conditions if the supply is cut short by strikes or railroad blockades. Where the conditions are favorable for the use of oil it makes an ideal fuel, requiring no handling, making no smoke or ashes, and allowing the fire to be regulated with the utmost nicety. Buckwheat anthracite coal is used largely by power-houses in the Eastern cities. It is of high calorific value, clean, making no smoke and little ash, and capable of being readily handled in coal conveyors and mechanical stokers. In the Western cities soft bituminous coal is used by force of necessity. This brings with it the troubles of ash, clinker and dirt, and in the city renders necessary some form of smoke consumer. As has been stated, it usually happens that the choice of fuel is a matter of location, but in cities where several competing grades of coal come to market, it would probably pay to have expert tests made to determine what grade of coal or what mixture is most economical for the work.

It is hardly within the limited scope of this article to discuss the numerous forms of coal and ash conveyors which have been put in use. We may say in a general way that in power-houses handling large quantities of coal, where the coal is delivered at the same place, as by rail or boat, the installation of coal and ash handling machinery will pay. Where coal is delivered in small quantities and where it is delivered in wagons and may be dumped at any part of the boiler-room the reverse may be said. The advantage of this form of apparatus is its saving of labor, and its disadvantages are its great first cost, its expensive maintenance, and the fact that it is desirable for the best service that the coal should be fairly uniform in size, which is a requirement not always easily fulfilled.

In the East the use of mechanical stokers has grown to such an extent that no large power-house is considered complete without them. In most of the Western cities, however, and especially here in St. Louis, the mechanical stoker has not been a success. This difference in results may be attributed to the difference in the fuels used. The buckwheat coal of Brooklyn and Philadelphia feeds evenly on the stoker and causes no trouble by cementing the grate bars together by clinkers. With the soft, fragile, bituminous coal however, clinkers soon form on the grate bars, and very often the fire must be almost completely destroyed to remove them. No mechanical stoker will bear crowding to any great extent, and any power-house using them must be supplied with a greater capacity of boilers than one where hand firing is the practice. By reason of the fact that the coal is introduced gradually into the hottest part of the fire and the volatile matter slowly driven off, the mechanical stoker is a partial smoke consumer. With the exception of this, there is no advantage in the use of mechanical stokers except the labor saved, as the great efficiency which was formerly claimed for them has never been proved in actual practice.

Notwithstanding the great number of types of boilers on the market, they may be divided into two general classes, fire tube and water tube. In most of the more recent power-houses some form of water-tube boiler has been adopted, as this type possesses some marked advantages over the fire-tube. They are non-explosive; they may be operated at a higher pressure and consequently are more suitable for use with compound engines; they have a large heating surface and are quick to respond to calls for power; they occupy less floor space and are usually more intelligently designed than the other class. On the other hand, their first cost is greater; there is a greater number of joints to be looked after and the cleaning is more difficult, especially in those forms which use a curved tube. It has usually been considered that the efficiency of water-tube boilers was much higher than the fire-tube, but there is now a form of fire-tube boiler being made, consisting of a shell of large diameter and extra length, containing a large number of flues, which approaches the water-tube boiler very closely in efficiency. The high efficiencies obtained in boiler tests are seldom reached in actual practice, as they usually result not so much from excellence of design in the boiler itself as from careful and intelligent firing during the test.

It is hardly necessary in presenting a paper before this intelligent body to discuss the reasons why water should be fed into the boilers as hot as possible. Besides preventing the straining of the boiler shell from the sudden changes in temperature, there is a large quantity of fuel saved, and the percentage of this saving will be found tabulated in nearly every work on thermo-dynamics. The usual methods employed in heating the feed water are: First, by the heat of the exhaust steam, and second, by the heat of the escaping flue gases. There are numerous patented devices for utilizing the heat of exhaust steam, either by passing the exhaust through a number of pipes surrounded by the feed water, or by spraying the feed water across an opening through which the exhaust steam is admitted. Most of these devices are very simple in their construction, and their efficiency depends very largely on the length of time the feed-water and the exhaust steam are in contact, and in case they are in separate chambers, upon the conductivity of the separating medium. Care should be taken that the opening for the exhaust steam is never contracted, so that any possible back pressure on the engine is avoided.

The method of heating feed water by the heat of the escaping flue gases has been applied in apparatus under the general name of economizers. The arrangement usually employed is a coil of pipe containing the feed water placed in the flue. In order to keep the soot from settling on the pipes, most forms of economizers are supplied with a mechanism for scraping off the pipes whenever necessary. By means of a properly designed economizer, feed water may be heated to a very high temperature, even above the atmospheric boiling point of water. In the use of any device in which feed water is heated by the flue gases, care should be taken that the escaping gases will still retain sufficient heat for the maintenance of the necessary draft after part of their heat is taken from them by the feed water. In the case of power-houses using natural draft economizers should not be used, where the draft is not already sufficiently strong, or is just barely strong enough for the work to be done. There are in operating, however, many plants using natural draft, discharging flue gases at a very high temperature, much higher than is necessary to maintain the required draft. Economizers used in such cases would result in a marked gain in economy.

Whatever system of heating feed water is used, the apparatus should be made abundantly large for the work to be done; first, that the water should pass through slowly and receive the full benefit of its contact with the heated gas or steam; second, that a large store of water may be kept on hand, which is of great service in case of a

* Extract of paper read before the St. Louis meeting of the American Street Railway Association.

sudden demand on the boilers; and third, that the feed water heating apparatus may act as as a water purifier. It has been found that water kept for some time at a high temperature will deposit a great portion of the carbonates and sulphates of lime and magnesia which it has in solution. This is probably due to the expulsion by the heat of the carbonic acid gas contained in the water, thus freeing from solution the lime and magnesia, which it is well known are slightly soluble in water containing carbonic acid gas.

With condensing plants the waste from the condensers is never at a greater temperature than 100 degrees Fahr. and if hot feed water is desired the use of an economizer becomes almost a matter of necessity as the water from the pumps and the other non-condensing machinery would not have sufficient effect in heating the feed water of a large plant.

Several of the large power-houses built during the last few years have abandoned the use of stacks for producing draught, and are operating by means of an induced draft produced by fans placed in the flue or short stack. In this case the stack is just high enough to clear the roof. This system has many advantages. First, there are no stacks to blow down or fall down, and this point is of special importance in a region subject to tornadoes. The second and most important advantage, however, is the absolute control which it affords in governing the fires, and this point will appeal especially to those power-houses subject to sudden and rapidly changing loads. As an illustration of this may be cited the power-house recently erected to operate the Baltimore Tunnel road. A great part of the time there is no load on the power-house, as it is only operated when there is a freight train to be hauled through the tunnel. The manner in which the load is handled is as follows: The boiler room is supplied with blowers in place of stacks, and a slow fire is kept constantly under each boiler. When a telegram is received that a freight train is approaching the blower is started, and on the arrival of the train steam has been raised in sufficient quantity to supply the great demand put upon the boilers. This illustrates the extreme flexibility of the system, and it would be difficult to handle this load in any other manner. Economizers are operated with great efficiency in connection with an induced draft, as this system permits the flue gases to be robbed almost entirely of their heat, since it is not necessary to have a large quantity of heat in the flue gases in order to create a proper draft.

Passing from the steam generating system to the engines, we find, as a connecting link, the system of piping. In regard to the general plan of the piping, opinion is very much divided. Some favor a single header with leaders to the engines. Others claim that a complete duplicate system is necessary, so that a failure in any part of the system need not cause a serious stoppage. The objection to a duplicate system is the greatly increased cost. In the installation of a duplicate system it is only human that the material and workmanship employed will be cheaper than if a single system were employed, because it is reasoned that if one side breaks down, there is always the other to be depended upon. The other side, however, is often never used until a case of necessity arises, and on account of this very lack of use, the valves and joints are apt to be found leaky and in bad condition when suddenly put in operation. A compromise system has been used in some cases, in which all pipes are duplicated, each side, however, having only one half the capacity required, necessitating the use of both sides at all times. In case of accident to one side the other half of the system may be used, at a disadvantage, of course, by increasing the steam pressure. The best plan, however, seems to be to use a single header divided at convenient intervals by valves, according to the size of the plant and the number of units employed, and in laying out the system to use only the best valves, material and workmanship. The power-houses having the least amount of trouble with their piping are those having a simple system. All steam and hot water pipes should be covered, so as to prevent as much as possible loss of heat by radiation and consequent condensation of the steam. And in this connection it should be noted that there is a great difference in efficiency in the different kinds of pipe covering. Tests have shown that the magnesia plastic and sectional coverings and the asbestos fire felt covering give the best results. (*Journal of the Association of Engineering Societies*, January, 1895.) A water separator should be placed in the leader to each engine. It should be large in size and placed as close as possible to the engine. A number of patented separators are on the market, but very good results may be obtained by the use of a simple, large tank with the steam entering at the side and leaving at the top and supplied at the bottom with a connection to a steam trap to catch any water collecting in the separator.

STEAM CONSUMING APPARATUS.

The question of the selection of the proper engine to operate the plant is so dependent upon what dynamo is to be used, that it will be best to abandon our arbitrary classification temporarily and take up first the question of the dynamo. During the past four years the street railway generator has undergone a radical change. In the Spring of 1893 there were installed in this city in the power-house of the Cass Avenue & Fair Grounds Railway Company, then being built, the first large, direct-driven generators of the type which has since become so common. Soon after this the Intramural power-house at the World's Fair was put in operation, containing one generator of the same size as those in St. Louis and another of twice the capacity. Since that time there have been few large power-houses built in which direct-driven generators have not been installed, and some of the large railway systems have found that economy of operation required a change from the belt, counter-shaft and unit of small size to the large direct-driven generator. At the present time the West End Railway Company, of Boston, which may be considered the pioneer in this country in electric traction, is changing its Central power station, which had originally been equipped with a very complete and elaborate system of belting and counter-shafting, to a direct-coupled plan.

The first cost of the direct-coupled generator is about 35 per cent. more than the belted generator in the 500-kw size, which is the largest standard size in which the belted generator is made; but when the expense of the belt, belt-tightening device, and the floor space is taken into account, the direct-connected generator will be found the cheaper. Besides obviating the necessity of the costly and cumbersome belt, the direct-connected generator offers the following advantages; in large sizes and in connection with large engines it has a much higher efficiency than the belted unit; it requires a small floor space; it aids supervision by bringing the working parts of the engine and generator close together; it reduces danger; it is almost noiseless in operation and it may be installed in a larger unit than the belt driven generator, which is limited in size by the width of the belt and pulley which may be employed. The main objection which was urged against the direct-connected generator was the fact that the shocks resulting from overloads were thrown directly on the engine and that there was none of the cushioning effect that a belt connection might supply. While this is undoubtedly true, the best argument which may be submitted against it is that none of the installations of direct-driven generators can trace any trouble to this source. The large, slow speed, multipolar, direct-driven generator has become perhaps the most prominent feature of the modern power-house, and while there may be special services which would necessitate a belted arrangement, it is difficult to imagine a power-house thoroughly up to date without direct-driven generators.

By varying the number of poles and the number of armature conductors in the construction of a dynamo the machine may be designed to run at almost any reasonable speed; the slower the speed, however, the greater being the cost of the dynamo. In the matter of speed it is necessary for the dynamo maker and the engine builder to effect some sort of a compromise, because it is not good practice to run such large engines at too high a speed. The speeds which are most common are 75 revolutions per minute for the 1500-kw dynamo, 80 to 120 revolutions per minute for the 800-kw dynamo, and speeds running from this to 150 revolutions per minute for the smaller sizes. These speeds are what would have been considered, four years ago, quite out of the range of the Corliss valve gear, but the makers of this type of engine have risen to the occasion, and now there are numbers of large Corliss engines driving generators at speeds up to 100 revolutions per minute, and some have even higher speeds than this. Several other types of engines have been adapted to this work and are running quite successfully. Outside of the question of valve gear, most engines made for this work possess the same characteristics, the heavy bed-plate, the solidly constructed fly-wheel, now being made of steel plate, the wide cross-head, the large connecting-rod and the mammoth main bearings.

The choice between horizontal and upright engines is chiefly one of space. The horizontal engine is the cheaper, the simpler, the easier to inspect and the easier to repair. Outside of the advantage of requiring less space, the upright engine has the advantage of less wear on the cylinder, and a more direct strain upon the foundations.

The usual practice in the most modern power-houses is to install

compound engines. Most of these plants are so favorably situated that condensers may be operated in connection with the engines. This is undoubtedly good practice, but in case condensers are not used the cost of fuel must be very high for the gain in compounding to pay for the extra investment. Where power-houses are favorably situated on bodies of water, condensing becomes a very simple problem, but in case the power-house cannot be built on a body of water, as in St. Louis, for instance, in order to use condensing engines some sort of arrangement must be designed to cool a quantity of water so that it may be used over and over again for the purpose of condensing the exhaust steam. Devices of this kind have long been in use in the City of San Francisco and in Cuba, and lately several of the large manufacturing companies have put on the market complete apparatus for the purpose of cooling water after it has condensed the exhaust steam, so that it may be used again for the same purpose. Besides the gain in power by using condensing engines it is claimed that by the use of this apparatus actually less water is used than if the steam is exhausted directly into the atmosphere without condensing.

In the use of large direct-connected units a great deal of the economy to be gained depends upon the selecting of the proper sizes. The efficiency of a generator will be good when it is operated at more than 75 per cent. of its capacity, but the efficiency of an engine drops off very rapidly when it is running below its rated load. In order to achieve the best economy from the use of large direct-connected units, the sizes of the different generators should be so proportioned that it is always possible to operate one or more units at their rated capacity. The railway generator, as at present built, will stand an overload of 50 per cent. for several hours without trouble and at a maximum efficiency. This should be taken into account in the estimate of the dynamos required, but it should always be the aim to have at least one idle machine to throw on the line in case of failure of any of the others. The actual size of the units depends upon the character of travel which the road possesses and the number of cars, and this must be determined for each road independently. In choosing machines, however, standard sizes should always be adopted, as this obviates any trouble in obtaining supplies and repair parts.

The railway generator switchboard has become standardized to the extent that it consists of a panel for each generator, each panel containing the usual automatic circuit-breaker, ammeter, field rheostat, field switch and main switch. It is hardly necessary to mention that there should be nothing combustible about the board, and it is not an absolute necessity for the board to contain a marble tablet inscribed with the illustrious names of the president, vice-president and secretary. Switchboards as now erected usually contain a recording wattmeter and an ammeter, which shows the total output of the power-house. The recording wattmeter especially is a valuable instrument, as by means of its readings exact records of the power-house may be kept.

The modern method of line construction is to divide the trolley into sections and connect each section separately to the main bus-bars through feeder panels, each of which contains an automatic circuit-breaker, an ammeter and a switch. This method confers the advantages that trouble on the line is always indicated on the proper section, and that in case of short circuits on the line, the main circuit-breakers are protected by the section circuit-breakers and the load is not suddenly thrown off the engines by the opening of the main circuit-breakers. Most of the generators and feeder boards are supplied with devices for preventing damage to the station machinery by lightning, but a very simple and effective arrangement is to connect a large water rheostat between the positive bus-bar and a good ground. This is either left in circuit continuously with a small current running through it, or is cut into circuit on the approach of a storm.

Besides those machines, which are absolute necessities in a power-house, there are various devices which may be added to secure convenience and regulation. An overhead crane is installed in the engine room of most of the large modern power-houses and adds greatly to the speed with which heavy repairs may be executed. An oiling system of some sort, by which the oil is either pumped or flows by gravity to the different bearings, obviates the necessity of manual labor in oiling and insures a steady feed at each bearing. A recording steam gauge is found very useful in checking up the firemen. An air-pressure system is beginning to be used in many of the power-houses, by means of which the carbon dust may be blown out of the armature windings. With this apparatus an armature may be kept thoroughly clean and the danger lessened of short circuits occurring on account of the collection of carbon dust between its conductors.

If readings be taken of the total output of the power-house at stated intervals and then plotted, a load curve will be obtained. A study of such a curve will show a very small load through the night from half-past one to half-past five, a sudden rise at this point to a maximum about 7 a. m., a lower load through the middle of the day, followed by another peak between 6 and 7 at night, after which the load again suddenly drops. In order to accommodate the machinery to the varying load, the number of dynamos in circuit must be constantly changed, and even then it is almost impossible to suit the power at all times to the load, the dynamos running much of the time either overloaded or underloaded, which, of course, means a sacrifice of economy. In addition to the variation of load shown by the curve, there is a momentary fluctuation, due to the starting and stopping of cars, the violence of which decreases with the number of cars in service. It is proposed to remedy this variation and operate the dynamos under a steady load by means of a storage battery plant connected in parallel with the line, charged from the dynamos during the period of light load, and discharged into the line on the heavy call for power. Installations of this sort have been placed in several of the large electric light plants, where they are operating with marked success, and there is no reason why they should not meet with the same degree of success in electric railway plants. By means of this auxiliary plant, the proper number of dynamos are run throughout the entire day at their full capacity, and hence at their highest efficiency, the battery taking care of all eccentricities in the load, charging when the load is less than the capacity of the dynamos, and discharging when the load exceeds this. The steam plant may be shut down entirely during part of the night, leaving the battery to operate the road, and in case of a break-down, the battery may be used to take care of the entire load for a short time. The battery is discharged through a booster dynamo, which is so designed that the compounding of the dynamos and the battery are the same. This arrangement is entirely automatic, so that no hand regulation is required. The efficiency of a battery operating under conditions of this kind will be guaranteed by the manufacturers to be greater than 75 per cent., and a maintenance of 6 per cent. per year on the first cost of the battery will be guaranteed. The great drawback to this system of operation is the large first cost of the battery, which is about $100 per horse-power capacity figured on a two-hour discharge rate. A storage-battery plant may also be used to increase the capacity of an existing power-house, and thus save the necessity of adding more machinery. There is another use to which a storage-battery plant may be put which will perhaps appeal more strongly to the street-railway man. This is to install it as a sub-station to maintain the voltage at the ends of long feeders which are subject to fluctuating loads. In this case the batteries are charged from the distant power-house and discharged into the trolley wire. The feeders from the power-house to the storage batteries are figured only for the average load instead of the maximum load, as would be necessary in case the line is fed directly from the power-house. The economy in this installation depends very largely upon the difference in cost between the feeders in the two cases. Besides the question of economy, however, the sub-station will give the better service, as the voltage will not fall and rise with the fluctuations of the load.

A number of power-houses operating long lines are now equipped either with boosters or high-voltage dynamos. Long lines usually have a booster constantly in circuit. The machine is automatic in its action, and raises the voltage with every increase in the load. Some power-houses operate a high-voltage dynamo for use on sections which are subject to excessive loads. The feeder-boards in this case are equipped with an extra bus-bar, so that any section may be thrown on the high-voltage machine.

While each individual engineer has his own ideas concerning power-house construction, and while each road building a power-house may purchase different apparatus, there is one general design which has been followed in many of the plants recently installed. It has been adopted by so many different engineers and in so many different places that it might almost be called the modern power-house. The engine-room and boiler-room are divided by a brick wall and under different roofs; both are brick buildings covered with an iron truss roof; the boiler-room is set on the grade of the street, and the engine-room 10 or 12 feet above this grade, the space below the engine-room being utilized for the piping and condensers; the engine and boilers are set at right angles to the wall between them,

with the engines close to the boiler-room so that the piping is made as short as possible and the condensation lessened; the switchboard and feeder-board are set on the opposite side of the room from the boiler-room, so that the length of the dynamo cables is equalized as much as possible. The general features of this design may be summed up as follows: It is compact, to save real estate and buildings and to minimize the number of employees and the superintendence. Large units are used for the sake of economy and to save the number of working parts. The building is, as far as possible, fire-proof.

The electric part of the problem has been solved, temporarily, at least, by the adoption of the multipolar, direct-coupled dynamo. The large, slow-speed engine has followed as a necessary consequence, and the general direction of improvement in power-house construction seems to be toward the use of devices to prevent the waste of heat and to minimize the labor required.

There can be no more appropriate place to quote the proverb that cleanliness is next to godliness. An engine and dynamo room should be kept scrupulously clean. This is especially true in regard to the electrical devices, as a very small amount of grease and dirt in the wrong place will cause serious damage. Beyond the mere æsthetic consideration that cleanliness improves the looks of things, there is also the fact that a thorough cleaning amounts to a rigid inspection, and small leaks and defects are often discovered in this way which might otherwise pass unnoticed until they had become serious matters. It is to be regretted that this advice is not more generally followed, as there is more lost through dirty and greasy electrical devices, badly set valves, leaky steam joints, poor firing and careless supervision than ever will be gained through the use of compound condensing engines.

As a means of comparing different kinds of machinery, figures as to cost of operation have been collected from some of the large modern power-houses, and their comparison reinforces what has just been stated, that less depends upon the refinements of the machinery than upon the condition in which the apparatus is kept and upon the supervision to which it is subjected. Among those having the lowest cost of operation was a power-house equipped with direct-coupled generators, but operating single cylinder, non-condensing engines, burning soft coal and using hand firing, while among those having the highest cost of operation are several power-houses supplied with compound condensing engines, and burning anthracite coal. The lowest results are about three-quarters of a cent per kilowatt-hour, some records running slightly below this, while the results from some of the large stations are as high as one and a quarter cents per kilowatt-hour. These figures include the cost of coal, water, supplies, repairs and all labor, but do not include anything for taxes, insurance, interest or depreciation. The cost of operation depends largely upon the cost of coal and upon the relation of the average load to the total capacity of the power-house, the higher this ratio the less being the cost of operation.

The modern electric railway power-house, although it has been developed entirely within the past 10 years, represents the thought and experience of many men. It has been developed carefully, detail by detail, until it is now a work both of reliability and efficiency. No one man and no one company can claim the credit for this achievement, but no class of men hold a stronger claim to recognition than the managers and owners of street railway properties who have ever been ready to encourage with their patronage such improvement, and who have freely distributed the information gathered by their experience, and who, even in the most radical departures, have ever acted with the courage of their convictions.

Mr. Steinway's Opinion of Compressed Air.

Mr. William Steinway, president of the New York Rapid Transit Commission, in discussing the question of electricity or compressed air said: "Other things being equal, there is one factor which, to my mind, would settle the issue between the two motive powers. Electricity could be used for lighting purposes as well as motor power, and hence a single plant would suffice, while two would be necessary if the motor power were to be compressed air. I have studied both motive powers a good deal. Compressed air as a motive power is worked under such a terrific pressure that the least disarrangement of the gearing would decrease the power at once. Besides, it is necessary to stop the car at intervals to charge it, and this will take a minute and a half at about every mile. There are, in short, objections to compressed air which make its utility for the underground road extremely doubtful. I tried it thoroughly on the line at Steinway, L. I."

Admittance and Impedance Loci.*

BY FREDERICK BEDELL.

The quantities chiefly considered in the discussion of alternating currents are E. M. Fs. and currents, the values of these being determined for different conditions. E. M. Fs. and currents are commonly represented by vector diagrams; and the change in these diagrams, as some one quantity is varied, is shown by the loci of the vectors which are altered thereby. What may be termed E. M. F. and current loci are thus determined. The numerical values for which these are constructed neces sarily depend upon some condition involving an assumed value either of the current or of the E. M. F.; thus we may assume a

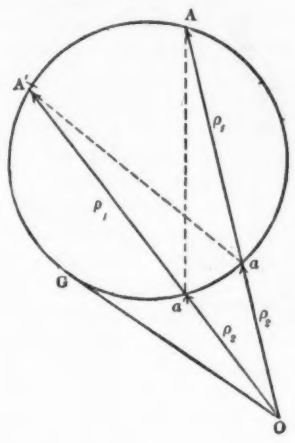


FIG. 1.

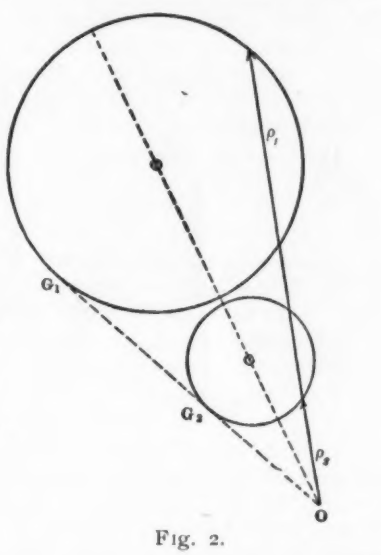


FIG. 2.

certain current to be constant (as the primary current of a transformer), and construct an E. M. F. diagram with loci, showing the changes in the various E. M. Fs. as some part of the circuit is changed; or we may assume the impressed E. M. F. constant and ascertain current loci for the same variation. Let us limit ourselves to the transformer. In the first case above it will be found that the constant assumed primary current I_1 is a factor in the value of every line representing the components of the primary E. M. F. E_1. By factoring out I_1 we have an impedance diagram simi-

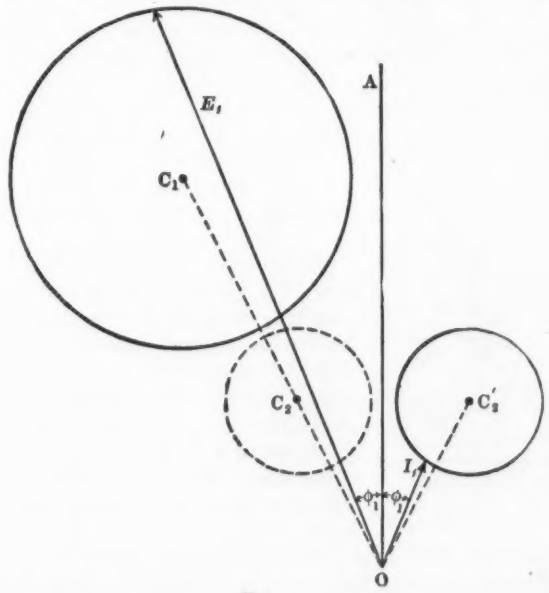


FIG. 3.

lar to E. M. F. diagram, and without any assumption as to the value of the current or E. M. F. Similarly, each line in a current diagram, constructed for a constant impressed E. M. F. E_1, represents a current which is a multiple of an admittance (the reciprocal of an impedance) and the factor E_1. By factoring out E_1 an admittance diagram is consequently obtained, similar to the current diagram but with no assumption as to the current or E. M. F. Admittance and impedance diagrams accordingly correspond to cur-

* Read before the Physical Society of London, June 26, 1896.

rent and E. M. F. diagrams, respectively, differing from them only by a factor.

Impedance and admittance loci, or E. M. F. and current loci, for the primary of a transformer, will in general be arcs of circles for changes in any one of the constants of the primary or the secondary circuit.

Some interesting relations arise from the reciprocal nature of admittance and impedance. Let us note the following relations between reciprocal vectors:

If any vector has an arc of a circle for its locus, a vector proportional to its reciprocal will have an arc of a circle for a locus. In Fig. 1 let ρ_1 be any vector from the origin O, having its locus as

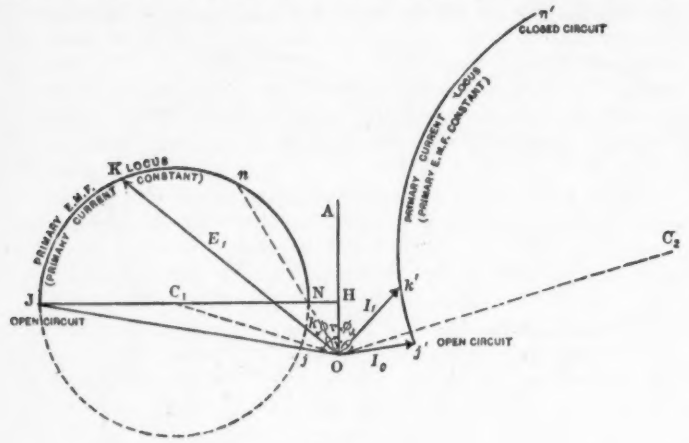


FIG. 4.

shown upon the arc of a circle. The vector ρ_2, drawn in the direction of ρ_1, and proportional to its reciprocal, will have its locus upon an arc of a circle, which may be shown as follows: Let ρ_1 and ρ_1' represent the vector in any two positions, OA and OA'. The intercepts Oa and Oa' will represent the reciprocal vectors ρ_2 and ρ_2'; for, in the similar triangles $OA\ a$ and $OA a,'$

$$\rho_1 : \rho_1' : : \rho_2' : \rho_2.$$

Hence $\rho_1'\rho_2' = \rho_1\rho_2 =$ a constant.

The value of this constant product of ρ_1 and ρ_2 is $\overline{OG}^2$.

By a suitable selection of scale, the loci of ρ_1 and its reciprocal ρ_2 may be represented as arcs of the same circle, as in Fig. 1; or they may be represented by different circles, as in Fig. 2. In the latter case

$$\rho_1\rho_2 = OG_1.OG_2 = \text{a constant.}$$

As the origin O approaches the circle which represents the locus of ρ_1, the centre of the reciprocal circle becomes more distant, and its radius becomes greater. When the origin O is a point in the circumference of the first circle, the centre of the reciprocal circle is at an infinite distance; that is, the reciprocal locus is a straight line.

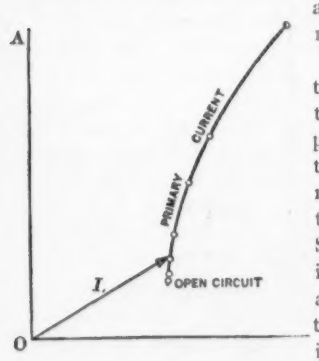


FIG. 5.

Let us apply these principles to the transformer diagrams. The locus of the primary impedance, as some particular quantity is varied, is a portion of a circle. For example, this may be shown to be the case when the secondary resistance is varied. Since the admittance of the primary is the reciprocal of its impedance, the admittance may be represented by the vector ρ_2 in the above construction, if the impedance is represented by ρ_1. These loci may be drawn to scale for actual values.

In a constant-current transformer, the primary E. M. F. varies directly as the primary impedance. In a constant-potential transformer the primary current varies directly as the primary admittance. But the admittance is the reciprocal of the impedance; hence, if we have an arc of a circle for the locus of the primary E. M. F. when the primary current is maintained constant, we may employ the above method to obtain the arc of a circle, which will be the locus for the primary current when the transformer is supplied with a constant E. M. F. The converse operation may likewise be performed.

In Fig. 3 let the circle C_1 represent the locus of the primary E. M. F. E_1 during some particular change of condition, the primary current meanwhile being maintained constant and in the direction $O\ A$. The difference in phase between the current and E. M. F. is the angle ϕ_1. The locus of the primary current under the same change of conditions, if the primary E. M. F. is maintained constant, is the dotted circle C_2, which is reciprocal to C_1. If the constant E. M. F. is drawn in the direction $O\ A$, the locus of the primary current is the circle C_2', drawn so that the angles $A\ O\ C_1$ and $A\ O\ C_2'$ are equal.

An application of the method of reciprocal vectors is shown in Fig. 4. Positive rotation is counter-clockwise. The semicircle $J\ K\ N$ represents the locus of the primary E. M. F. of a transformer, when the primary current is constant and is in the direction $O\ A$, and the secondary resistance is varied.

The E. M. F. has the position $O\ J$ on open circuit, and $O\ N$ on short circuit. $O\ H$ is the power E. M. F. on open circuit, and includes the effects of primary resistance and the losses due to hysteresis and eddy currents; $H\ J$ is the E. M. F. to overcome the primary self-induction. These are in the direction of the primary current, and at right angles to it, respectively. A line from J to K, at right angles to the secondary current, would show the reaction of the secondary upon the primary. It is to be noted that the line $N\ H$ represents the effects due to magnetic leakage. It is desired to find the locus for the primary current when the primary E. M. F. has a constant value, and is drawn in the direction $O\ A$. The angle of lag θ_1, between the primary E. M. F. and current on open circuit is $J\ O\ H$. Accordingly, with a constant E. M. F. in the direction $O\ A$, the open circuit current I_0 is laid off lagging behind the E. M. F. at an angle of $A\ O\ j' = \theta_1 = J\ O\ H$. The open circuit current I_0 may be laid off to any convenient scale. To construct the locus for the primary current, proceed as follows: Lay off the line $O\ C_2$ so that the angles $A\ O\ C_1$ and $A\ O\ C_2$ are equal. The point C_2 is located so that $O\ C_2 : O\ C_1 :: O\ j' : O\ j$. The primary current locus is then drawn as the arc of a circle with C_2 as a centre passing through j'.

The limits of the primary E. M. F. locus are the points J and N. The corresponding limits of the primary current locus are the points j' and n'. It will be noted that these points correspond to the points j and n on the circle C_1, which are reciprocal to the points J and N.

In the absence of magnetic leakage the points N and H coincide. The point n' would then lie in the line $O\ A$. The deviation of the primary current locus from the line $O\ A$ is produced by magnetic leakage.

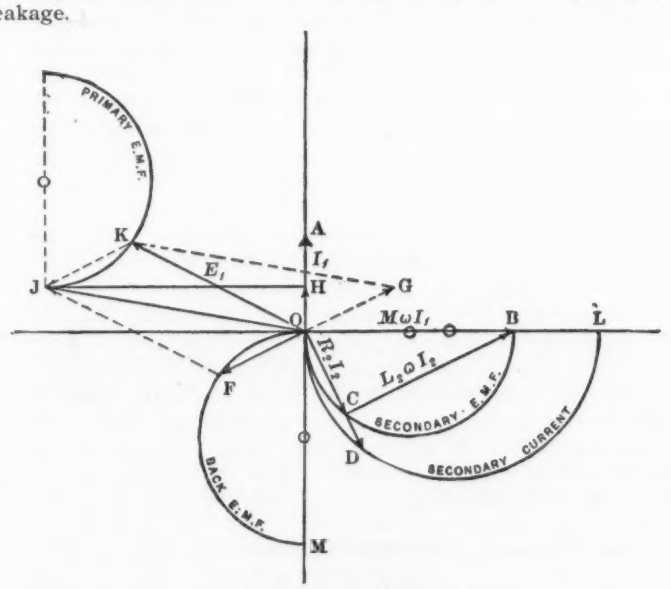


FIG. 6.

An experimental curve showing the primary current locus for a constant potential transformer, as affected by magnetic leakage, is shown in Fig. 5.

The reciprocal relation between admittance and impedance vectors gives a simple method for determining the conditions for consonance and resonance in transformer circuits.[1]

Fig. 6 is given as a particular instance in illustration of the statement given above that loci produced by the variation of any one constant are usually arcs of circles. The primary loci are always

[1] "Resonance in Transformer Circuits," by Bedell and Crehore, the *Physical Review*, vol. 2, p. 442.

arcs of circles. The diagram shows the changes due to variation in the secondary self-induction.

Fig. 7 shows the effect of magnetic leakage. The curves shown are loci for primary E. M. F., when the primary current is I_1. The primary E. M. F. is composed of the components $O\ H$, to overcome ohmic risistance and supply open-circuit losses, $H\ J$ to overcome self-induction, and (with absence of magnetic leakage) $J\ K_0$ to overcome the back E. M. F. of mutual induction.

The semi-circle $J\ K_0\ H$ is the locus for the primary E. M. F. in the absence of magnetic leakage. The semi-circle $J\ K'\ N$ is the locus for the primary E. M. F. when the coefficient of magnetic leakage ς is constant from open circuit to short circuit. In this case we have the relations :

$$\frac{J\,K'}{J\,K_0} = \frac{J\,N}{J\,H} = \frac{M^2}{L_1\,L_2} = (1-\varsigma)^2;$$

$$1-\varsigma = \sqrt{\frac{J\,K'}{J\,K_0}} = \sqrt{\frac{J\,N}{J\,H}};$$

$$\varsigma = 1 - \sqrt{\frac{J\,K'}{J\,K_0}} = \sqrt{\frac{J\,N}{J\,H}}$$

In an actual transformer the magnetic leakage is not constant, but varies with the load. The locus represented by the dotted curve $J\ K''\ N$ is for such a case in which the magnetic leakage is zero

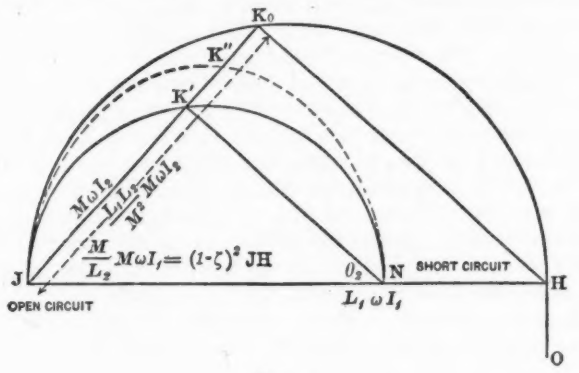


FIG. 7.

on open circuit and increases to the maximum at short circuit. Where the magnetic leakage is variable, it is determined for any point, as $K,''$ by the ratio of $J\ K''$ to $J\ K_0$.

$$\zeta = 1 - \sqrt{\frac{J\,K''}{J\,K_0}}.$$

Thus let us suppose that the back E. M. F. $J\ K''$, actually induced in the primary by the secondary current I_2, is 81 volts ; and that $J\ K_0$, which would be the back E. M. F. in the absence of magnetic leakage, is 100 volts. We then have the equation

$$1 - \zeta = \sqrt{\frac{81}{100}} = \frac{9}{10} = 0.9,$$

which indicates that the mutual induction is nine tenths of the value it would have in the case of no magnetic leakage. The coefficient of magnetic leakage is accordingly found to be 10 per cent., thus:

$$\zeta = 1 - 0.9 = 0.10.$$

Fig. 7 is drawn to represent the values of the various E. M. Fs. in the primary circuit of a transformer, for a given value of the primary current and for different values of the secondary resistance. If the magnitude of each line is divided by the primary current I_1, Fig. 7 represents the values for the primary impedance (without any assumption as to constant current or E. M. F.) for different values of the secondary resistance. The effect of magnetic leakage upon the primary impedance of any transformer is thus shown for different values of the secondary resistance.

The above construction affords a simple method of studying the conditions for a decrease of the primary impedance of a transformer when the secondary circuit is closed.[1]

Curves corresponding to the dotted curve in Fig. 7 have been experimentally determined[2] by the writer.

[1] Discussed at length before the Physical Society by Mr. E. C. Rimington in his paper on "Air-Core Transformers," *Philosophical Magazine*, Vol. 37, p. 394.

[2] Proceedings of the International Electrical Congress, Chicago, 1893, p. 234.

A New "Three-Wire" Dynamo.*

BY ALEXANDER ROTHERT.

Direct-current installations for lighting and power, operated on the three-wire system, have become very general, but would enjoy a still greater popularity were it not for the necessity of running two small machines in place of a large one. In order to avoid this the division of the difference of potential must be accomplished by equalizing machinery, so that the cost of installation remains approximately the same.

The utilization of the storage battery alone for the division of potential does not offer sufficient reason, and is, therefore, not applicable in all cases.

On account of the increased expense of the three-wire system in consequence of machinery, electricians have tried to construct dynamos directly applicable for direct-current three-wire networks. Up to the present time a number of more or less successful solutions to this problem have been proposed, but none sufficiently satisfactory to satisfy all conditions required of a good three-wire dynamo. By putting a third brush on a direct-current commutator half way between the positive and negative brushes, the neutral may be attached to this brush, but being in the midst of a strong magnetic field it sparks badly, so that regular running is out of the question. A better solution offers itself by winding the armature of a dynamo in two sections, attaching two commutators and connecting them in series, connecting the neutral to the middle. A very interesting method for connecting any ordinary dynamo to a three-wire system has been proposed by Dobrowolsky and is being used by the Allgemeine Elektricitäts Gesellschaft and the Compagnie de Frères-Lille.

Collecting rings are attached to two points on the armature, which are at a maximum difference of potential. These rings are connected together by means of a choke coil, from the middle of which the vertical wire goes out.

The problem of division of potential is thus solved but not the possibility of keeping constant or regulating each branch separately. The drop in the armature as well as in the line is different in both branches according to the variation of the load, but the total pressure of the exciting current may of course be varied. Should each side be regulated separately, the uneconomical method of outside armature resistance must be resorted to. A very good result is only possible if the current in the two branches is exactly or nearly alike ; in most cases a difference of more than 10 to 15 per cent. is not permissible.

It may also be added that the use of a second collector as well as the choke coil for the division of the total potential difference causes not by any means negligible losses ; in spite of their faults these methods have been employed. These are the solutions of the three-wire single machine problem up to the present time. I now have reached the real subject of my paper, which is the discussion of the new "three-wire" machine of the E. A. G., formerly W. Lahmeyer & Co., in Frankfort-on-the-Main.

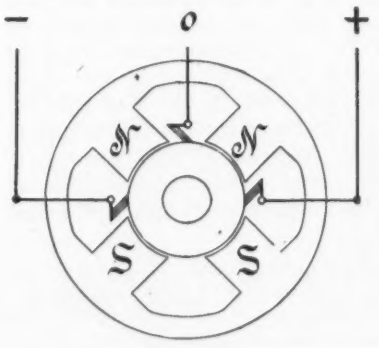


FIG. 1.

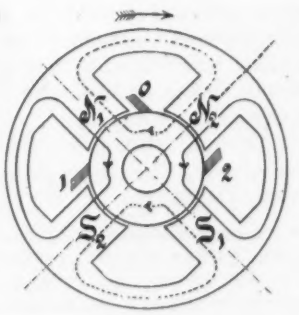


FIG. 2.

The invention was made about two years ago and got beyond the experimental stage last year. To-day several of these machines are in actual use.

Two things are to be considered in such a machine :

1. The division of the potential.

2. Independent regulation of each branch, that they may be loaded differently over considerable ranges.

The first was obtained by a third brush between the positive and the negative, and in order to avoid the sparking another neutral was created by allowing each pole to consist of two distinct sections.

* Paper read at the International Congress of Electricians at Geneva.

Thus we have a four-pole magnet into which a two-pole armature is introduced. The middle brush runs, as demonstrated by experiments, sparkless.

The first problem, the division of the potential, is therefore solved. Before going over to the regulation of each single branch we must stop to consider the magnetic relations and actions of such a machine. Fig. 2 shows the distribution of the lines of force. The magnifying force of the armature is perpendicular to these. This magnetic force, due to the armature, also tends to create a field whose lines of force would run as shown by the dotted lines.

A glance at Fig. 2 shows that the armature lines of force are opposing the exterior field at N_1 and S_1, and at N_2 and S_2 they are in the same direction.

The poles N_1 and S_1 are thus weakened, while the poles N_2 and S_2 are strengthened by the armature reaction. Since two oppositely situated and unequal poles always act inductively on the same branch of the three-wire system, the load will cause the potential to change, that in branch 1–0 will sink, the other rise. If the potential shall remain constant the excitation of spools, N_1 and S_1 must be increased, and analogously that of N_2 and S_2 must be weakened, in order to neutralize armature reaction. Thus in practice coils N_1 and S_1 are annexed in series, and also N_2 and S_2. Each branch has then its own regulating resistance.

Since, as we see two opposite poles act on but one branch, any change in the excitation of the respective coils allows the change and regulation of each part independently; in fact one branch may be left idle while the potential in the other branch is raised. Thus the problem to satisfy all conditions is solved.

It was found afterward that the idea of separating the poles in order to attach a third brush has been previously mentioned by Müller; the division alone, however, does not allow of a regulation of the branches, and is therefore of but theoretical interest, first as that of Kingdon, who patented a "three-wire" dynamo in England which is similar to the one here mentioned, and has also four poles. Kingdon, however, suggests to put like poles in series, thus losing the opportunity for regulation.

After having thus discussed the principle of this new dynamo, this may be applied to multipolar machinery. It is simply necessary that two consecutive poles are of the same polarity, and the total number must be a multiple of four. Most large machines having eight poles may be changed to a double four-pole machine. With a judicious application of this principle machines for four and five-wire systems may be built, if a sufficient number of poles with equal polarity are side by side.

After the first machine had left the experimental period, the demand was so great that the manufacture of same was undertaken on a large basis. It was found, however, that in running the machine is apt to reverse partially in polarity. Assume coils N_2 and S_2 cut out, and only N_1 and S_1 excited, the lines of force will tend to get into the adjacent poles and reverse their polarity. This had to be overcome. This was obtained by exciting the two branches alternately, that is, to connect N_1 and S_1 to the terminals 0–2, and *vice-versa* coils N_2 and S_2 to 1—0. Now one branch can only be excited after the other has a difference of potential, or both must reach pressure together. Reversing does not happen any more. Another advantage of this connection lies in the fact that the machine has the tendency to keep the polarity up, thus reducing the necessity for regulation. Should the potential fall, then the exciting current will to some degree decrease; but since each branch tends to carry its changes over to the other branch, these differences are easily equalized.

G XI. THREE-WIRE DYNAMO, 2 x 110 VOLTS, 340 AMPERES, 500 REVOLUTIONS.

LOAD TEST.

Branch I.		Branches I and II.		Branch II.	
Potential.	Exciting current.	Current strength.	Revolutions per minute.	Potential.	Exciting current
110	12	340	500	110	2.3
110	9.6	220	510	110	2.65
110	8.5	155	500	108	2.75
110	6.6	75	525	110	2.8
110	5.6	0	525	111	3.2

Going over from theory to practice, it may be mentioned that these machines have been built by the E. A. G. firm, Lahmeyer & Co., in large quantities, and that several have been running for 18 months with excellent results. The largest models are 100-kw machines, with eight poles and a four-pole armature, making 450 revolutions per minute. In the table the results of a load-test of a 75-kw machine are given, from which the changes in the excitation for different loads may be deduced. A 75-kw dynamo for 2 x 110 volts excites considerable interest in the Berlin Exposition on account of the difference in load on the two branches. It happens frequently that one branch is loaded with 400, the other with 200 amperes, without noticing any change in the working of the machine. The invention of this machine is again a proof that even in this advanced field considerable progress can be made.

Acetylene Regarded As an Electrolyte.

There are two standpoints from which to view acetylene, says the London *Electrician*—one that it is a member of the $C_n H_{2n-2}$ series, and therefore a simple hydro-carbon, in which case there appears no ground for supposing that it can perform the function of an electrolyte; the second by considering its tendency to form metallic derivations when it appears to be of an electrolytic nature. Messrs. H. C. Jones and C. R. Allen finding that the molecular conductivity of an aqueous solution of acetylene is similar to that of acetic acid concluded that acetylene, on solution, suffers electrolytic dissociation. Attracted by this statement, and hoping to discover carbon acting as an anion in fused or dissolved salts of acetylene, i. e., carbides, Herren G. Bredig and A. Usoff have studied bodies of the type Ag_2C_2 CaC_2, and detail their conclusions in the *Zeitschrift für Elektrochemie*. The repetition of the experiments of the former pair of investigators goes to show that their results are erroneous, and that the molecular conductivity of acetylene is exceedingly small.

The present authors state that acetylene is a very weak electrolyte, and so must be ranked as an acid of the feeblest description. "The salts of acetylene must be almost completely hydrolized in aqueous solution, a result to be expected from the known reaction of calcium carbide with water. On account of this fact the old view that silver acetylide contains oxygen becomes intelligible, for water, regarded as containing the ions H and OH, acts upon Ag_2C_2 and gradually forms from it silver oxide, Ag_2O. The progress of this hydrolysis is dependent on the number of H and Ag ons, whence it follows that Ag_2C_2 is most readily prepared from an ammoniacal solution in which the number of H and Ag ions is considerably smaller than in pure water. A direct proof of the same tendency is afforded by the fact that a solution of sodium chloride becomes alkaline when shaken with Ag_2C_2." The ultimate conclusion reached by Bredig and Usoff is that acetylene is not perceptibly dissociated in aqueous solution, and that it stands in a position intermediate between electrolytes and non-electrolytes.

Multiple-Facet Eyes of Insects.

To the Editor of The Electrical World:

Sir:—The discussion of the Röntgen phenomena by the British Association developed among other things an erroneous statement. The wide reputation of the person making the statement in question has given this general circulation in the lay and technical press.

Following remarks on hyper-phosphorescence, the statement was added that probably insects having lensless eyes were able to visualize by means of Röntgen rays. The reference here is evidently to the fixed or multiple-facet eyes of insects.

The writer has in his possession a most interesting lantern-slide made by Dr. G. F. Allen, of Aurora, Ill. The eye of a beetle was placed in the camera as a substitute for the ordinary lens, and an exposure made on the black profile of a head on a white background. The resulting multigraph was circular and contained several hundred distinct images of the profile, one indeed for each facet in the eye. The "Gem" camera employed for taking a large number of simultaneous photographs of an object is the physical analogue of such an eye. The relation of such an eye to that of the mammals is that of a fixed focus camera to one in which the focus is adjustable.

It seems reasonably clear that insects form their judgments of distance from such multiple images, depending upon the power of each facet to refract light rays. It is scarcely conceivable that rays not capable of refraction, or of being focused, can by simple shadow effects enable a judgment as to the distance of an object to be formed.

W. M. Stine.

Armour Institute of Technology, Chicago, Ill.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Cast Steel for Dynamos. Elek. Zeit., Oct. 15.—A set of curves and tables of the magnetic properties of the metal made by the Bergische Stahl Industrie at Remscheid; the results are those obtained by the the Reichsanstalt, by Prof. Ewing and by the manufacturers themselves; the former were made in 1894 and those by Ewing in July, 1896. Ewing in his report states that after strong magnetization the value of the coercive force was found to be 1.7 C. G. S. units, a value which is very low and shows that this material is to a high degree a very small hysteresis loss; he adds that his tests show that this steel is an excellent material for the magnets of dynamos.

Designing a Bipolar Drum Dynamo. R. KENNEDY. Lond. *Elec. Rev.*, Oct. 16.—The first of a series of articles intending to give the simplest arithmetical processes used in designing dynamos; the present portion gives certain simple rules for the armature, including a table from which the fundamental dimensions, that is the diameter and length of the armature, for any given output may be found; the rules given are very simple and seem to be based on experience.

Rotary Transformer. HANAPPE. *L'Eclairoge Elec.*, Oct. 17.—a detailed discussion of a 5-kw machine, including working drawings and the results of extended tests shown in the form of numerous curves.

Sparking. FISCHER-HINNEN. *L'Eclairage Elec.*, Oct. 17.—A French translation, apparently in full, of the German article abstracted in the *Digest*, Oct. 10 and 17.

Determining the E. M. F. Induced by a Portion of a Gramme Ring. LOPPE. *L'Eclairage Elec.*, Oct. 17.—A reprint of the article noticed in the *Digest*, Oct. 17.

Lessons in Practical Electricity. Am. Elec., October.—The generation of continuous currents is considered. The principle of the commutator is treated somewhat differently from the usual method, its functions, it is stated, being first, to add together the E. M. Fs. generated in the individual armature wires, and second, to divide into sections the sine variation of the E. M. Fs. in the individual wires such that when the E. M. Fs. of the various wires are added, at every instant a decreasing E. M. F. in one wire is offset by an increasing E. M. F. in another, thereby, with a sufficient number of segments, approximating to a constant brush E. M. F.

Transformer Primary Turns and Secondary Voltages. BAECHTOLD and PARKER. *Am. Elec.*, October.—Referring to an article in a previous number in which it was shown that increasing the number of primary turns of a transformer will decrease the secondary voltage, a case is cited in which the secondary voltage was considerably increased when part of the winding had been removed from the primary.

LIGHTS AND LIGHTING.

Electric Lighting of the Exhibition at Geneva. RITTER. *L'Ind. Elec.*, Oct. 10.—The beginning of a description of the lighting of this exhibition; it seems to be chiefiy of local interest; 240-volt lamps were used as an experiment, but owing to the inconstantcy of the voltage their mortality was very high as they are very sensitive to changes of voltage. For a series of 25 arc lamps a continuous current was used, being obtained from a 2400-volt diphase current by means of a motor directly coupled to a generator, the total loss of transformation being 16 per cent. A brief description is also given of the Alioth rotary transformer which transforms the alternating current directly into a continuous one by means of a single armature with both slide rings and a commutator.

Artistic Fittings. Lond. *Elec.*, Oct. 16.—Three illustrations of recent designs.

Electric Railway Incandescent and Arc Lamps. Amer. Elec., October.—A descriptive article, with many illustrations, showing the principal types of such lamps on the market. The field for commercial lighting from trolley circuits is discussed; it is limited by insurance rules, franchises and effect of lamp load on station load curve during Winter months; for lighting villages and small towns along interurban roads, the electric railway arc lamp is thought to have a distinct field of profit.

POWER AND HEAT.

Electric Power in Workshops. HILLAIRET. *L'Eclairage Elec.*, Oct. 17.—The reproductions of some diagrams made by registering instruments, showing the power taken by motors in driving machines, such as saws, planers and boring machines; the article is to be continued.

Refuse Destructor in Budapest. L'Ind. Elec., Oct. 10.—A brief description of a small installation in which the city refuse is used to generate steam for a 100-hp engine; a short line three miles long has been constructed to carry the refuse to the destructors.

Transmission of Power in Mines. R. KENNEDY. Lond. *Elec. Rev.*, Oct. 16; a continuation of his serial.—He gives a brief history of the invention of the polyphase motor, and states that the chief obstacle in the way of its general adoption in mining work is the litigation difficulty.

Elevators. SPEISER. *Elek. Zeit.*, Oct. 15.—A well-illustrated description of the devices used by the Schuckert Company.

Gas Engines for Isolated Plants. Prog. Age, Oct. 15.—The results of a test made with a 10-hp engine to so show the advantages of using it as a reserve in a water-power station. The precise meaning of the test is not clearly stated, but it is shown that there would be an average saving of about 60 per cent. In the engine described the amount of the charge is regulated instead of diminishing the number of ignitions, and the engine therefore runs more uniformly; it is also claimed to be very easy to start it.

Alternating Motor for Farm Work. DALLAS. *Elec. Eng.*, Oct. 28.—A brief description of a successful application, the plant being, he believes, the first instance of such an installation operated by an alternating-current motor; in the present case a 7.5-hp motor was used at about six miles from the plant and operated a thresher; it worked satisfactorily, with the exception of the large starting current.

Hydraulic Power in Switzerland. SUPLEE. *Cassier's Mag.*, November.—An illustrated description of some of the large water-power plants, many of which are used for electric transmission.

TRACTION.

Return Circuits for Electric Railways. MONMERQUE. *L'Eclairage Elec.*, Oct. 10; a conclusion of his article (see *Digest* Oct. 24, under Prevention of Electrolysis).—He discusses the subject in all its phases, and makes a number of mathematical deductions, illustrating them with numerical examples. He first considers the case of a return consisting entirely of the rails, giving formulas for the calculation of the proper cross-section of the rails; he then discusses return feeders, and shows that it is more economical to make these of steel wire instead of copper; he shows how to calculate the maximum length of a line for which no return feeders need be used. Among his conclusions he states that electrolysis need be considered only if metallic pipes run in the direction of the rails, or if in general such pipes are very numerous; the rails should be chosen with respect to their electric conductivity as well as their mechanical strength; while each case should be considered separately, yet in general it is to be recommended not to exceed five volts' loss in the return circuit; in most cases a satisfactory solution is reached by using the rails alone as returns; every case should be considered separately, and any such fixed rule as that adopted by the English Board of Trade, in which the loss of voltage in the return circuit should not exceed seven volts, is an unnecessary restriction.

Storage-Battery Traction. DAWSON. Lond. *Engineering*, Oct. 16.—The present installment of his long serial on electric traction is devoted to storage-battery traction and contains tabulated data of a number of lines on which accumulators were tried, and of the accumulators themselves; it seems to be a fairly good collection of this data. Of these lines there are only two which are worth describing, the one in Paris and the other in New York, both of which he describes; the Birmingham line will probably soon be transformed into a trolley system; he thinks the mixed system used at Hanover, in which the accumulators are carried by trolley cars, being charged from the line and used only over short portions where the overhead wires are prohibited, promises to be a fair success, but it has been in use so short a time that no figures are obtainable; the weight of the 108 cells used on the Paris line is 6615 pounds, and each car runs about 37 miles with one charge.

Odawara Railway, Japan. Elec. Friend (Japan), August.—The eight-mile horse-car line is to be changed to an electric line using water-power as the source; all the machinery is to be imported from America. Permission has also been granted to use electricity on a new 15-mile line from Arima to Kobe.

Liverpool Overhead Railway. COTTRELL. Lond. *Elec. Eng.*, Oct. 16.—A reprint apparently in full of his recent paper noticed in the *Digest* last week (see also THE ELECTRICAL WORLD, Oct. 31, p. 520).

Steam Engiues for Electric Railway Service. Am. Elec., October.—An illustrated article describing 15 types of American engines employed for

electric railway service. The writer, after pointing out the great advances recently made in the design of engines for this service, states that there are several points in regard to which there is still a difference of opinion among designers. High estimates of the value of cylinder jacketing are questioned, ratios of heating surface in intermediate receivers to engine horse-power vary widely, and there are most conflicting results bearing on the proper ratios of cylinders at given pressures. The value of the relation between length of stroke, or speed, and steam economy, is also a very uncertain quantity; the general opinion, it is stated, is tending toward what may be called moderate speed in contradistinction to what have been termed high and low speeds. The present practice with respect to speed is stated to be as follows: For engines from 300 to 800 horse-power, 150 to 120 revolutions per minute; from 600 to 1000 horse-power, 150 to 100 revolutions per minute; from 1000 to 2500 horse-power, 120 to 90 revolutions per minute.

The Evolution of the Electric Railway Motor. Child. *Am. Elec.*, October.—A profusely illustrated article tracing the history of the street railway motor from that of Davenport down to the latest types of to-day, and 1896 types of the Walker, Westinghouse, General Electric and Steel Motor Companies are illustrated and described in detail.

A Test of Span-Wire Insulation. Daniell. *Am. Elec.*, October.—A spring wire is attached to the trolley pole but insulated from it. A prolongation of the spring comes in contact with the span wires as the car passes beneath them, and a flexible cable leading down into the car from the other extremity of the spring connects with a voltmeter, which indicates when the spring touches a defective span wire.

Repair of Electric Railway Apparatus. Shepard. *Am. Elec.*, October.—The Walker electric railway motor is the subject of this installment of the serial.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Pre-Payment Meters. Lond. *Elec.*, Oct. 16.—An editorial notice stating that as such meters have proved to be a great benefit to gas companies, it is now proposed to introduce them for electric supply; the arrangement, which is briefly described, is intended to be fitted to any meter; the penny which is inserted acts as a buffer to two links of a switch, and on turning the handle the lights are turned on, if the penny is in the position, and at the same time a ratchet wheel, gearing into the counting train, is turned back a corresponding amount and a light is lifted; when the latter has descended to its lowest point everything resumes its original position; it consumes electrical energy only at the moment of switching off.

Hachioji, Japan. Elec. Friend (Japan). August.—A brief description of the electric lighting plant in this city, which is near Tokyo. The plant is operated by a water-power four miles from the city; a 50-hp Pelton waterwheel is used under 220 feet head with a 2000-volt alternator, all the machinery being made in Japan.

Nice. L'Ind. Elec., Oct. 10.—A long, illustrated description of this central station, in which a three-wire 110-volt system is used in connection with accumulators.

Edinburgh. Lond. *Elec. Rev.*, Oct. 16.—A brief description of the station in connection with an engineers' meeting, held in that city.

Block Stations. Knocke. *Prog. Age*, Oct. 15.—A translation in abstract of a recent article in *Dingler's Journal* in which the relative advantages of block stations with gas engines and of large central stations are discussed; each case must be considered on its own merits, as there can be no general solution. Some data is given for the block station at Frankfort-on-the-Main, which is run by gas engines, and an estimate is given of the cost and income of such a station, showing that the income is much greater than that from large stations. He assumes a capacity of 1200 lamps; the station would occupy about 1000 square feet, would contain two dynamos directly connected with gas engines; there would also be a battery of accumulators consisting of 62 cells and having a capacity of about 500 ampere-hours; the distribution is by the simple two-wire system at 110 volts, with which a district of about 2000 feet in diameter can be supplied; the second dynamo acts as a reserve. The costs are worked out in detail; the total is given as $14,294; the cost of operation is about $3200 at 40 cents per thousand cubic feet of gas or $3800 at 80 cents. He concludes that in cities in which there is no central station, especially those in which the gas works are operated by the municipality, small block stations should be constructed in preference to large steam central stations.

Test of an Isolated Gas Engine Lighting Plant. Beyland. *Prog. Age*, Oct. 15.—The results of a test made with a small plant in a church, and run by a janitor; the tests were made by engineering students. The engine developed 10-horse-power; the tables and curves show the cost of lighting per hour for different loads, as also for the same lighting by gas, and it was found that above 30 lamps it was decidedly cheaper to use the gas engine and dynamo.

WIRES, WIRING AND CONDUITS.

Stoneware Casting for Interior Work. Lond. *Elec.*, Oct. 16.—An illustrated description of a system of ducts with one inch holes and three ducts to the piece, the distinctive feature being that the ducts are partially cut through longitudinally, leaving sufficient material for strength but enabling the ducts to be readily opened if necessary by means of a chisel, which is done only if it is necessary to get access to the cables.

Transmission Line from Niagara Falls to Buffalo. Dunlap. *Elec. Eng.*, Oct. 28.—An illustrated description of the line and its construction; 4200 feet of the 26 miles will be laid underground in ducts.

Interior Wiring. Am. Elec., October.—Special diagrams and explanations for special combinations such as electric signs, large chandeliers, special cabinet wiring, etc. A working drawing of a special cabinet board is given.

ELECTRO-PHYSICS AND MAGNETISM.

A Cathode-Ray Spectrum. Birkeland. *Comptes Rendus* No. 13; *L'Ind. Elec.*, Oct. 10; translated in the Lond. *Elec.*, Oct. 16.—In a recent paper he showed that a cathode discharge emits various groups of different rays which appear to behave in a manner analogous to the various notes emitted by a vibrating string (see *Digest*, July 4); in the present paper he describes how he has been able to separate out these groups as they are all differently deflected by magnetic force. As an anode he uses an aluminum disc with a narrow slot, the disc preventing the rays from the cathode from passing into the spherical part of the bulb otherwise than through the slot, very distinct yellow line of phosphorescence being formed on the wall of the tube when the anode is connected to earth, the width of the line changing with the pressure in the tube, being narrow when low and increasing with greater pressures; at low pressures there were two or three lines; on touching the glass with a finger one of the lines moved toward the finger. Two small electromagnets of equal size were arranged on opposite sides of the bulb below the slit so as to generate a field through the tube; a complete spectrum of diffused lines was then formed; when the primary current of the induction coil was varied gradually, the consecutive bands of this spectrum appeared suddenly one after another; a table of these results is given; he observed more than 10 of these bands, which he thinks are caused "by one or more lines in motion"; it is certain that the first band consists of a line oscillating perpendicularly to its length, the oscillations diminishing when the current increases; when the primary current is continuously increased the magnetic deflection of all the bands diminishes so that they draw nearer to one another; when the pressure in the tube is diminished, the current remaining constant, the magnetic deflection also diminishes continuously, first quickly and then slowly; he thinks the dependance of the magnetic deflection on the primary current and vacuum is due entirely to the spark parallel to the tube, that is, to the voltage; using a more volatile cathode of platinum he endeavored to find whether the particles of metal which are attached are deposited on the lines of the spectrum, but so far has obtained no definite results.

Röntgen-Ray Researches. Roiti. *L'Eclairage Elec.*, Oct. 17; an abstract from the Italian.—After describing the tubes which he used he gives the results of some of his observations. He showed that X-rays cannot emanate from gaseous particles; he was able to dissociate sulphuric acid; he described a photometer for X-rays consisting of a prism, the sides of which are covered with a phosphorescent substance, one of which is exposed to each of the sources and both of which may be seen at the same time, as in an ordinary photometer; to compare two tubes the rays are made to pass through openings, the size of which are varied until the two fluorescent faces appear equally illuminated. In the same way a tube may be compared with a light as a standard. Regarding the transmission of the rays through bodies, he found that the relative order of transparency remained the same for all the tubes examined; also that the order of the intensities of the tubes remain the same with different coils or voltages; also that the penetrating power of the rays from a tube do not vary proportionately with their power to excite phosphorescence; that rays which have traversed substances will afterward pass more easily not only through the same substances but through others also, that is, the absorbing power of a substance diminishes as the number of screens interposed in the path of the rays is increased; from this he concludes that it is impossible to give a table of transparencies of bodies for X-rays without indicating the source of the rays and the substances which they have traversed before they fall on the body.

Action of Metals and Salts on Röntgen Rays. Gladstone and Hibbert. Lond. *Elec. Eng.*, Oct. 16; a brief abstract of a B. A. paper.—They contrast the action of metals and their salts on the ordinary and on Röntgen rays. While ordinary light is absorbed completely by solid metals, the metals show every degree of opacity, with regard to Röntgen rays, from lithium, which is practically non-absorptive to gold and platinum, which are opaque; the salts of these metals are not transparent, but the metal in them seems to have the same effect on Röntgen rays as in the uncombined condition, and this seems to be equally true when the salts are dissolved in water; the order of absorption follows that of atomic weight, and not that of density or combining proportion; the absorption by a salt in solution appears to be that of both its constituents added together plus that of the solvent.

An Old Experiment Analogous to that of Röntgen. Holtz. *L'Eclairage Elec.*, Oct. 10; abstracted from *Wied. Ann.*, page 462.—He describes an experiment made by him in 1880, in which he found that the rays produced by opposing a point to a disc covered with silk would cause conductors to throw a shadow while insulators did not, as they were transparent to the rays. He contrasts radiations in air with those in vacuum.

The Dimension of Electric and Magnetic Quantities. JOUBIN. *L'Eclairage Elec.*, Oct. 10; a reprint of an article from the *Jour. de Physique.*—He discusses the dimensions of these quantities in terms of purely mechanical units, and showing that some indication is thereby given of the nature of the electric and magnetic phenomena; as, for instance, the similarity between electrostatic forces and capillary forces; in general electromagnetic phenomena depend on velocity, while the electrostatic depend on acceleration.

Electric Resistivity of Bismuth at the Temperature of Liquid Air. DEWAR and FLEMING. Lond. *Elec. Rev.*, Oct 16; a reprint of a Royal Society paper read June 4.—They give the results of experiments made with bismuth obtained by an electrolytic method and found to be exceedingly pure; the results are given in a table and show that when pure there was no tendency of the resistivity curve to take a minimum value; down to the lowest temperatures reached it continued to decrease in a perfectly regular manner and in nearly a straight line, showing that it is no exception to the rule and indicating that the resistance would vanish at absolute zero. With this material they repeated the experiments of the variations of the resistance when placed in a magnetic field, confirming their former observations, namely, that the effect of a transverse magnetic field in increasing the resistivity is immensely increased by cooling the bismuth to the temperature of liquid air; a table of the results is given and shows that while a field of 2750 increases the resistance only about 6 per cent., the immersion in the field increased its resistance more than four and a half times when it was at the same time cooled to the temperature of liquid air, as compared with that of the same temperature when not in the magnetic field; it was 50 per cent. greater than when not cooled and not in the field. Theoretically it would seem that pure bismuth, which would be a perfect conductor at absolute zero, would be converted into a non-conductor if placed in a magnetic field of sufficient strength.

Relation Between the Latent Heat of Vaporization and the Dielectric Constant. VAN AUBEL. *L'Eclairage Elec.*, Oct. 10.—An abstract of an article from the *Jour. de Physique.*

Magnetic Separation of Non-magnetic Material. WILKINS and NITZE. *Eng. News*, Oct. 22; an abstract of a paper read before the American Institute of Mining Engineers.—They divide magnetic materials into those which are highly magnetic and those possessing comparatively infinitesimal magnetic susceptibility; their paper refers to this second class. Delesse found that by representing the magnetic attraction of steel by 100,000, that of magnets would be 65,000, of siderite 120, of hematite 93 to 43, and of limonite 72 to 43. One method of separating out the practically non-magnetic iron ores is to first convert them into artificial magnetite, a process which gave good results, but the cost of the roasting and the uncertainty of the product led to further experimenting, the result of which was the Wetherill process; in this rather surprising results were obtained by using a very high magnetic power applied in machines especially adapted to the purpose, sufficient to attract almost infinitesimally magnetic particles; in this way garnet, fowlerite, tephroite and similar deleterious iron and manganese bearing minerals could be eliminated; a large number of ferruginous and manganiferous minerals such as hematite, limonite, siderite, garnet, pyrolusite, etc., could be concentrated. The ores are fed on a belt which carries them in a thin layer in close proximity to the magnetic poles which lift up the magnetic particles; machines have been used with a capacity up to three tons per hour; the current required is comparatively small; for the operation of Franklin minerals only three to eight amperes at 16 to 30 volts are necessary (but the output is not given); the ability to adjust delicately the magnetic intensity permits in many cases of practical isolation from one ore, several products having a slightly different magnetic permeability. It is difficult at present to judge of the full extent of the field to which this can be applied; its widest application will probably be in concentrating iron ores, red and brown hematites and carbonates, which constitute over 90 per cent. of the minerals used in the blast furnaces in this country; a number of special cases to which this process may be applied are given, as for instance in the extraction of the pure garnet or the removal of the deleterious ferruginous minerals in corundum. The plant at Franklin, N. J., having a capacity of about 400 tons of raw ore per day, is about to be operated. The results of some concentration tests are given.

Estimating the Size and Shape of the Heart by X-Rays. H. C. THOMPSON. *Elec. Rev.*, Oct. 28; reprinted from the Lond. *Lancet.*—He states that it has now become an accepted fact that the outline of the heart, and to some extent its movements, can be seen with the aid of Röntgen rays and the fluorescent screen; the former method of measuring the size of the heart, namely, the method of percussion, is unsatisfactory, owing to the numerous personal factors which enter, and a means of corroboration is therefore welcomed. The method which he has adopted is to place a piece of white paper on the back of the screen and trace the outline with a metallic pen introduced between the screen and the chest, the point of the pen being readily seen, so that the outlines can be traced without difficulty.

An Instructive Experiment. ANTHONY. WOLCOTT. *Am. Elec.*, October.—Answers relating to an experiment suggested in the previous issue, the object of which was to experimentally prove that a single north pole tends to move continuously along the whole circuit of a magnetic line of force in a direction from north to south. Mr. Wolcott describes an apparatus constructed like the one suggested, which, when tried, gave the desired proof.

Alternating Currents in Parallel Circuits. BEDELL. *Elec. Rev.*, Oct. 28.—An abstract of his B. A. paper, which was noticed in the *Digest* last week.

ELECTRO-CHEMISTRY AND BATTERIES.

Applied Electrochemistry. SWINBURNE. Lond. *Elec.*, Oct. 16; a reprint of his fourth Cantor lecture.—He discusses electrolytic caustic and bleach, copper refining and calcium carbide. Regarding the former he thinks too much attention is being given to electrolytic alkali and to details of the apparatus; the products are so low priced that there is not much margin to tempt inventors; the processes already in use are quite good enough to give enormous profits; the cost of the electrolysis is such a small portion of the total cost that great improvement in the vats would make very little difference in the price of the material; careful watching, testing and the finding out of the best conditions would be much better; he seems to favor the use of mercury as an anode and cathode; the claim that this use of mercury is poisonous is not well founded; he discusses at some length the recent statement of Hurter, who claimed that it is impossible to get strong caustic in an ordinary vat at a high-current efficiency. Regarding copper refining he states that there is but little to be said, as also regarding the electrolytic extraction of the metal from its ores; he ridicules the secrecy of those using these metals, and believes it would be much better to publish the results and compare notes; he points out the great importance of keeping down the amount of copper required in the works for carrying out the processes, that is, to make the copper go through quickly, and compares briefly the relative merits of the series and the parallel arrangements, questioning whether the former is the more economical; he mentions the Hayden method used in Bridgeport, Conn., in which a number of intermediate plates are used, one side of which is the anode and the other the cathode, the copper being refined in being transferred from one to the other. Regarding the use of cuprous chloride, which yields twice as much copper as the sulphate, with a given current, he shows that there are other things to be considered, such as the resistance, which may counterbalance the advantages. The generally-accepted belief that everything electrolytic is pure, is not necessarily true, such copper being nearly pure but generally containing antimony, the smallest trace of which does harm. Regarding calcium carbide, he limits himself to a discussion of its industrial application, showing that the extent of the latter depends very largely on the cost of manufacture; he assumes $50 a ton as the "final price" packed and delivered on the cars, after paying the manufacturer's profit and all charges, and on this basis he calculates what its future may be; the cost of acetylene should be compared with the prime cost of the present gas delivered in the mains, and the results would then be quite different from those obtained by the usual comparison; the actual value of the present gas at the main is really only a few cents per thousand cubic feet, and acetylene therefore has no chance in comparison; unless the cost of carbide is greatly reduced there is no chance of acetylene being used for enriching; he concludes that acetylene will not compete with gas at present in England, although it has a much greater future in America; but there is a very large opening for the gas apart from its competition with coal gas; experiments showed that acetylene is not at all a serious poison and it is not easily exploded; he hopes it will soon be made by non-electrical methods, which would reduce its price considerably.

Gold from Sea Water. LIVERSIDGE. Lond. *Elec.*, Oct. 16; a brief editorial on his recent communication to the Royal Society of New South Wales.—He gives the results of much careful and laborious work on the composition of sea water, and among other things finds that it contains about 0.5 to 0.8 grain of gold per ton, and it is probable that the amount is even greater; in round numbers the amount of gold found in the waters of the Australian coast ranges from 130 to 260 tons per cubic mile; if uniformly distributed at the rate of one grain per ton throughout the 400,000 cubic miles forming the contents of the ocean the total amount would be over 100,000,000,000 tons of gold.

Desilverization of Lead. TOMMASI. *L'Eclairage Elec.*, Oct. 17; a continuation of his article (see *Digest*, Oct. 24).—In the present portion he describes his process at some length, giving the data and an estimate of the cost of a plant. The principle on which the process is based is to electrolyze a lead solution which not only has a very low electrical resistance, but does not give rise to the formation of peroxide of lead and to use the silver-lead alloy itself as the anode, with a metallic disc which is non-attacked by the bath, as the cathode; the solution appears to be a double acetate of lead and sodium or of lead and potassium with an addition of other ingredients which he keeps secret.

Method of Making Thin Tubes of Metal. *L'Ind. Elec.*, Oct. 10.—A note describing the following method for the construction of very thin tubes of nickel; A rod is made of a fusible alloy, any desired form being given it, either curved or straight; this is then covered electrolytically with a coating of nickel of any desired thickness, being careful to have the deposit even; it is then placed in boiling oil, which melts out the alloy, leaving the tube of nickel. The process is used with success in the manufacture of tubes for metallic manometers.

Electricity Direct From Coal. Tommasi. *Elek. Zeit.*, Oct. 15.—Referring to the battery recently described by Coehn (see *Digest*, April 11, also July 11) he shows that he described the identical cell before the French Academy, in June, 1884; he gives a description of this as published in a French work, the elements consisting of carbon, salt water, porous cups, peroxide of lead and carbon; the E. M. F. is 0.6 to 0.7; it is applicable only for intermittent currents, as it polarizes very quickly; he reproduces the theory of the cell as published, from which he obtained a calculated voltage of 0.84.

Electrolytic Production of Potassium Per-Carbonate. Lond. *Elec.*, Oct. 16.—A translation in part of the article by Constam and Von Hansen, noticed in the *Digest* last week; it is accompanied by an editorial discussion.

Seat of the E. M. F. in a Cell. Swinburne. Lond. *Elec.*, Oct. 16.—A reply to the recent criticisms of Lodge (see *Digest* last week); he claims that the question is a mere matter of definition.

Polarization of Thin Metallic Membranes. Luggin. *L'Eclairage Elec.*, Oct. 17.—A reply to a recent article by Arons; he describes two new experiments.

UNITS, MEASUREMENTS AND INSTRUMENTS.

The Use of the Telephone in Measuring Dielectric Constants. Heydweiller. *L'Eclairage Elec.*, Oct. 10; abstracted from *Wied. Ann.*, page 694.—He deduces some mathematical relations to aid one in the use of a telephone for such measurements.

Localization of Faults in Electric Light Mains. Raphael. Lond. *Elec.*, Oct. 16.—A continuation of his long serial, the present portion being devoted to series arc-light circuits.

Faults in Rheostats and Arc Regulators. Am. Elec., October.—Instructions for locating faults in dynamo rheostats and in Brush and T.-H. arc regulators.

The Bunsen Photometer. McKissick. *Am. Elec.*, October.—The construction of an instrument for student's use is described.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Osumi-Formosa Cable. Elec. Friend (Japan) September.—This cable has been partially laid, the work on the remainder being postponed on account of the bad weather; it was laid entirely by natives, there being no foreigners on board the laying ships; the chief electrician is Mr. Asano; the cable ship *Okinawa Maru*, which is illustrated and described in the June and August numbers of that journal (see also *Digest*) was used for laying the cable, which was imported from England. The part from Osumi to Oshima, 238 knots, has an insulation resistance of 9.978 megohms per knot, and a resistance of 8.495 ohms; the results for the other portions are also given; the laying was accomplished satisfactorily.

Electrical Disturbances in Submarine Cables. Lond. *Elec.*, Oct. 16.—An editorial discussion of the arguments advanced by Mr. Preece in his recent paper (see Electrical World, Oct. 17, p. 459) regarding cables for telephoning through long distances; it consists essentially of a reference to this subject by Heaviside in his work on "The Electromagnetic Theory."

Japanese Submarine Cable. Elec. Friend (Japan), July.—The Japanese Government has contracted for a cable of English manufacture at a total cost of $91,250, including 43 knots of two-core deep-sea cable, 21 knots of single-core deep-sea cable, 50 of single-core intermediate cable and 28 of single-core shore ends.

Telegraph Offices in Buffalo. Terry. *Elec. Eng.*, Oct. 28.—A brief illustrated description of these offices (see also *Digest*, last week.)

American Telephone Practice. Miller. *Am. Elec.*, October.—The first installment of a serial. The history and principles of the magnetic telephone are treated in the initial article.

MISCELLANEOUS.

Electrical Engineering in Japan. Elec. Friend (Japan), June.—There were 63 graduates of the Engineering College in the Imperial University of Japan. Up to the present time there have been 633 students graduating as electricians, since the year 1879, the first of which was the late Prof. Shida, who graduated under Prof. W. C. Ayrton, who was there at that time.

Dividends of Electrical Industries in Japan. Elec. Friend (Japan), July.—The following are some of the dividends paid for the year ending June, 1896, in per cent. per year: The electric light companies at Tokyo 8, at Osaka 15, at Kyoto 18, at Yokohama 10 and at Kobe 12; the Kyoto Electric Railway Company 6, Tokyo Incandescent Lamp Mfg. Company 11, Osaka Electric Copper Refining Company 12, Tokyo Horse Car Company 36 and Tokyo Gas Company 15.

The B. A. Screw Gauge. Lond. *Elec.*, *Elec. Rev.*, *Elec. Eng.*, and *Engineering*, Oct. 16.—An abstract of a report of a B. A. committee, accompanied by a number of illustrations.

Electrical Exhibits at the Geneva Exposition. Guye. *L'Eclairage Elec.*, Oct. 10.—The beginning of a long, illustrated description of the electrical exhibits.

Present Status of Electricity. Baxter. *Cassier's Mag.*, November.—A short article, pointing out that the existing knowledge regarding electricity is much greater than is generally supposed; we know fully as much about it as about light and heat; he reviews briefly the numerous applications, showing that it is an exception to find one where electricity is not used in some way; as a science it is as far advanced as any, and there is no more guesswork in connection with its proper application than there is in any department of engineering.

The Electric Equipment of Brooklyn Bridge Cars.

The switching of the Brooklyn Bridge cars by electricity will shortly become an accomplished fact. The cars are being rapidly finished, and as they reach the yards of the Brooklyn Bridge railway will be fitted as fast as possible with the electric apparatus. The 20 car equipments form-

Fig. 1.—Third-Rail Insulator.

ing the order are now ready in the shops of the General Electric Company, waiting for the cars to reach Brooklyn.

The first car reached Schenectady from the shops of the Pullman Palace Car Company a few weeks ago, was fitted with the electrical apparatus, and is now in Brooklyn. The balance of the cars will be equipped at their destination.

The electrical equipment of each car consists of four G. E. 50-motors and two K-14 controllers, both especially designed for this work. The motors are completely encased, and are water tight and dust tight. The armatures are slotted, each coil lying in its own slot, and the method of winding followed allows of the removal of any coil with very little disturbance to the others. Each motor is provided with a roller which will

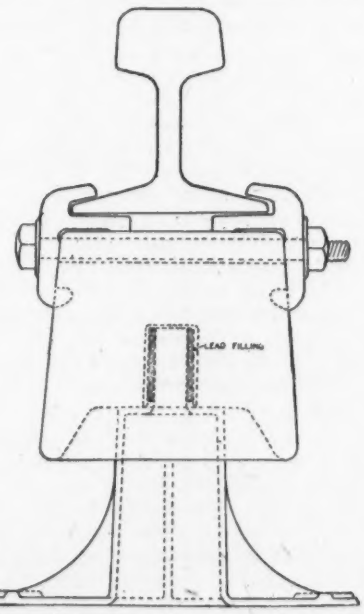


Fig. 2.—Cross-Sectional View of Rail Insulator.

come directly over the cable and prevent it from abrading the motor or injuring it in any way and from being injured itself.

The K-14 controller is the standard K type of controller which will be used in this case. Two circuit-breakers, a magnetic fuse box and 12

resistances complete the electrical equipment. The circuit-breakers are closed and opened from the platform, but are so placed that inspection can readily be carried out.

The duty which these motors will be called upon to perform will be to switch the four-car trains from the incoming to the outgoing platforms. When the trains are loaded the motors will push them forward over the tilting sheaves, where the cable will be taken up by the grips on the other three cars of the train. The conditions of the contract between the electrical company and the Brooklyn Bridge trustees require that in case of any failure on the part of the cable plant the four motors together shall be powerful enough to propel the fully loaded train weighing 120 tons across the Bridge at the speed of the cable, *i.e.*, 11.3 miles per hour. The capacity of the motors is such that they will be able to haul the heaviest Bridge trains up a 3.78 per cent. grade not only for the short 1000 feet—the length of that grade on the Bridge structure—but the whole length of Manhattan Island if necessary. The trucks of the new cars are from the shops of the McGuire Manufacturing Company.

The third-rail method of contact will be adopted, and current will be taken by four shoes to each motor car, two on each side. These are suspended from a support set between the journal boxes of each truck, and will be so hung as to give a perfect contact with the third rail. The third rails will be carried all the way across the Bridge alongside and parallel to the regular traction rails.

They weighed 45 pounds to the yard originally, but the bridge trustees are utilizing the old rails for this purpose. Every fifth tie projects a little further than its mates, and on it is mounted an insulator which supports the third rail. This is shown in perspective in Fig. 1, and a cross-sectional view of it is shown in Fig. 2. It is precisely like those used in Chicago on the elevated roads. The cast-iron pedestal has a small cylindrical top on which is fitted a large cubical block of vitrified clay. It is slightly tapering, being in fact a truncated pyramid, and the interior is hollowed out so as to form a single petticoat insulator. It is secured to the cylindrical top of the iron pedestal with a lead filling. A single bolt holds malleable iron clamps in place, which grasp the lower flange of the rail and fit into holes in the top of the insulator. The rail is grasped slightly before the insulator in order that the pressure on the latter may not crack it, and there is a slight play allowed for expansion and contraction. These insulators cost but 46 cents each. The rails are bonded together with two No. 10000 Chicago rail bonds. The third rail is divided into three sections, one from the New York terminus to the pier, the second across the span and the third from the Brooklyn terminus to the pier. These sections are electrically separate and separately fed. The third rails are fed by six feeders. Two go to the New York anchorage, two to the New York terminal and two to the Brooklyn terminal. The feeders are flexible cable, with a sectional area of 500,000 circular mils, and were supplied by the John A. Roebling's Sons Company.

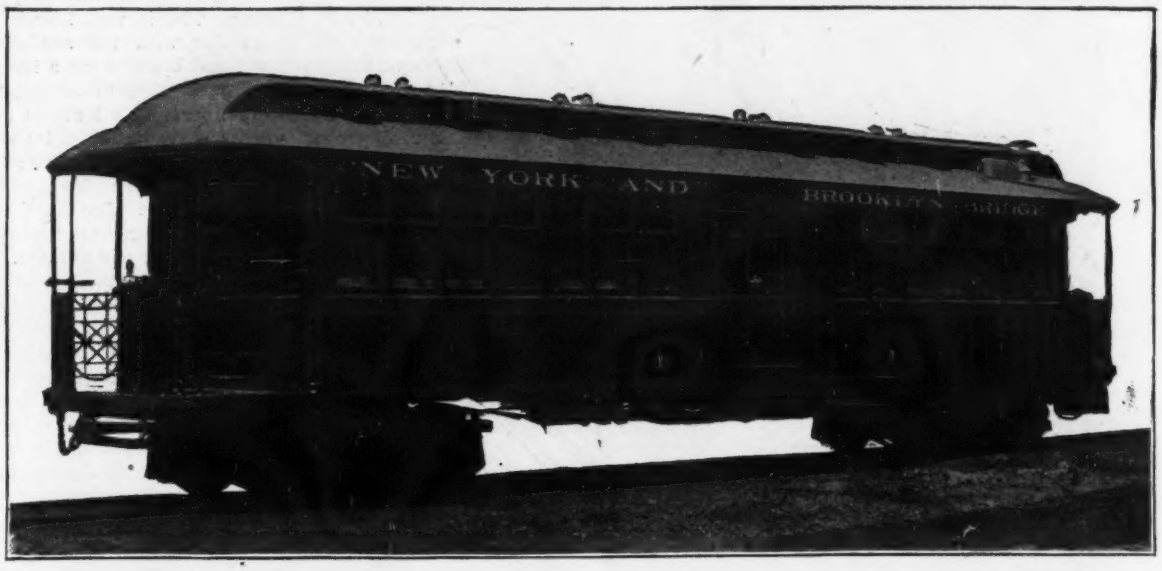


FIG. 4.—BROOKLYN BRIDGE CAR.

The loss in the line is calculated to be about 5 per cent. under full load. The feeders are set upon double petticoat glass insulators with glass saddles in the tops, the feeder resting on the top of the insulator. The overhead trolley will be done away with and the cars will be lighted from the circuit which feeds the motors.

As soon as the full number of motor cars is equipped and in service the steam locomotives will be taken off.

The question of the abandonment of the cable for the complete operation of the Bridge trains by electricity is one which will probably be settled in favor of the cable. The uniform speed given to the cars by the cable, and the fact that the cars, while attached to it, are spaced at regular intervals, eliminate from the operation of the trains a personal factor which might tend to accident, while by balancing up grade trains against those running down grade, the consumption of power is reduced to a minimum.

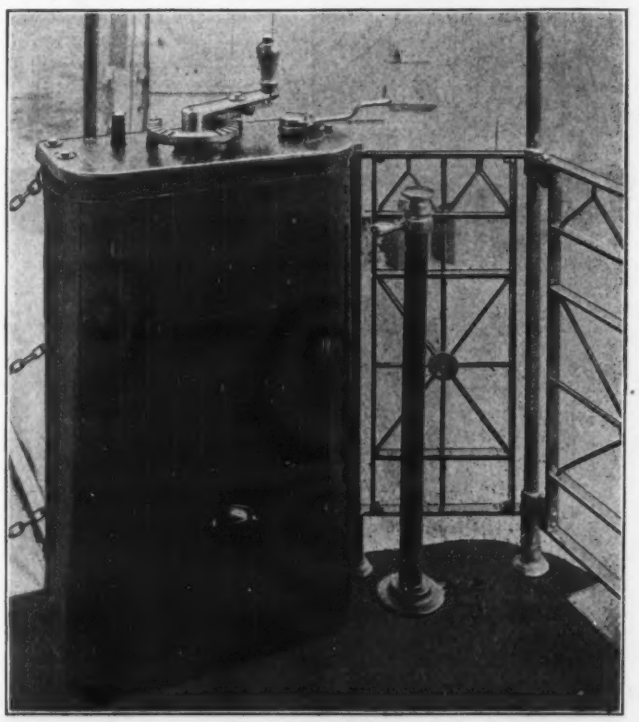
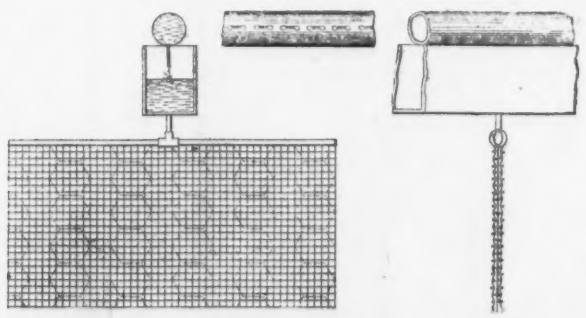


FIG. 3.—CONTROLLER ON CAR PLATFORM.

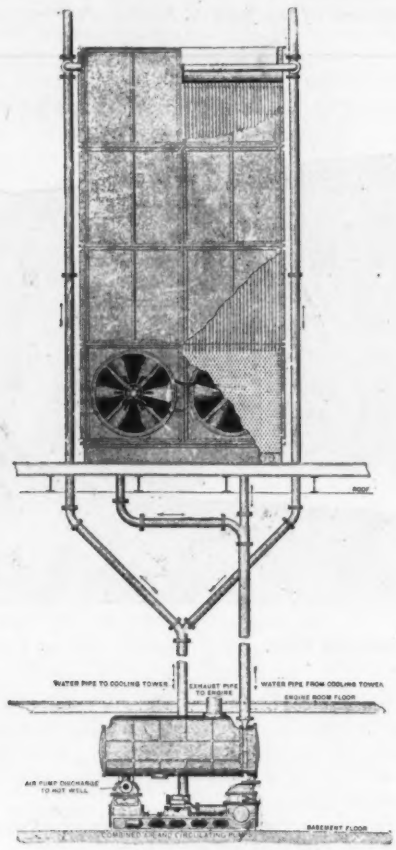
Water-Cooling Tower.

The output of an engine can be increased more than 10 per cent. by the use of a good condenser, but there are frequent cases in which the locality is such that a supply of water for cooling the condenser cannot be obtained except at great expense. In such cases as these the Barnard cooling tower is an extremely important adjunct. The principle of the new water-cooling tower, as its name implies, is to simply take the discharged water from the condenser and reduce its temperature in order that it may be used over again. The hot water from the condenser is pumped to the top of the tower and subdivided evenly and distributed over the upper edges of wire mats, uniformly flowing over them. A strong draught of air is forced through the mats, and the water as it is drawn off from the bottom and redelivered to the condenser is of a temperature



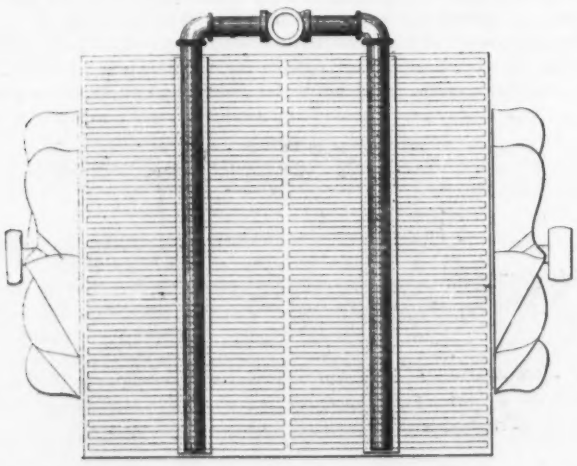
MAT AND METHOD OF DISTRIBUTING WATER OVER SAME.

so low that it would incline one to the belief that it came from the city mains or from some neighboring stream. The power required to operate the tower is practically negligible and the space required for its operation is from 2 to 5 per cent. of that of the main engine according to conditions. The pump may be placed on the roof or in some other elevated position if convenience demands it; this requires more power to be expended at the circulating pump. An electric station recently equipped with this apparatus is that of the Twelfth Street station of the Edison Electric Illuminating Company, of New York, in which the cooling tower


WATER PIPE TO COOLING TOWER
EXHAUST PIPE TO ENGINE
WATER PIPE FROM COOLING TOWER
ENGINE ROOM FLOOR
AIR PUMP DISCHARGE TO HOT WELL
BASEMENT FLOOR

Water Cooling Apparatus.

is some 70 feet above the condenser. The water is sufficiently cooled in transit through the long pipes to maintain 25 inches of vacuum without trouble. In a continual six-hour test on the De Laval steam turbine at the Twelfth Street station, the average load being 1402 amperes, the vacuum gauge ranged from 25 to 26 inches, averaging 25.6. In another test with an average load of 3628 amperes for five hours, the vacuum averaged over 25 inches. The exhaust steam averaged 13,535 pounds an hour, and the losses by evaporation were only 3 per cent. of the circulating water and did not exceed 80 per cent. of the boiler feed-water when the engines were working condensing. This water-cooling tower is particularly well adapted for use with the Wheeler condenser. The water



Plan Showing Supply Pipes, Tank and Distributing Pipes.

circulating pump on the Wheeler condenser is amply able to take care of any additional work that may be put upon it by being obliged to pump against a head due to the elevation of the cooling tower. The greater part of the lift is balanced by the down column of water from the other end of the cooling tower, and therefore the apparatus is wholly independent of elevation, the extra power being measured by the difference in height between the two columns, which is a little less than the length of the tower. The cooling towers are continually efficient; the wire mats are all galvanized after weaving and do not deteriorate with long and continued use.

The accompanying illustration shows the general arrangement of the tower and condenser, both of which are manufactured by the Wheeler Condensing & Engineering Company, Cortlandt Street, New York.

Long-Burning Arc Lamp for Incandescent Circuits.

Mr. F. E. Kinsman, who is well known in the electric light trade through his connection with the arc-lamp business from its early days, has developed and brought out a long-burning arc lamp, which is being handled by the Electric Construction & Supply Company, 110 Liberty Street, New York. This lamp is styled the "Kinsman" long-burning arc lamp, from the name of its designer, and it has been produced to meet the popular demand for an arc lamp that is applicable to incandescent circuits. It burns with a guaranteed life of 150 hours with one trimming of the carbons. The light is said to be steady, with no shadows, and is uniformly distributed through the globe. The construction of the lamp is both simple and durable. A single magnet operates a clutch against the carbon, as shown in the accompanying illustration, Fig. 2, and the entire absence of clockwork mechanism insures the wearing qualities of the lamp. The arc is entirely enclosed in an inner globe, thus insuring protection against any danger from sparks and entire freedom of carbon dust. These lamps use about 5 amperes of current at 80 volts across the arc and are run singly in multiple on the circuit, thus securing to the customer separate control of each lamp.

Another important consideration is the long life of the lamp obtained by one trimming of carbons. It is claimed that the Kinsman lamp on an average use of eight hours per day will need but 16 trimmings in one year.

Fig 1.

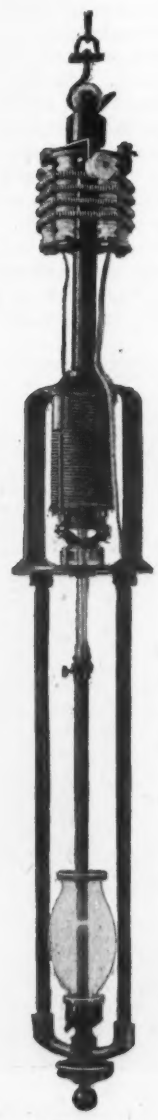


Fig 2.

The lamp represented in Fig. 1 is of the standard ornamental pattern and is designed for inside use. The standard plain lamp designed for

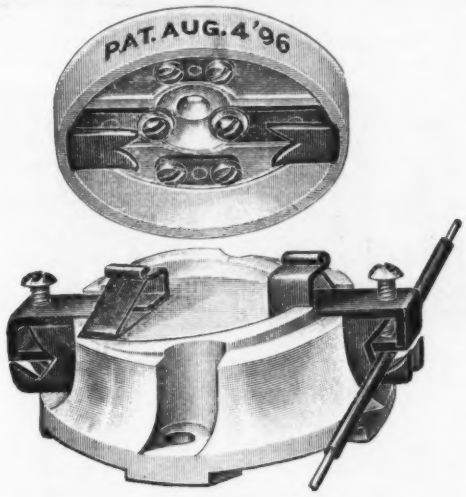
outside use is substantially constructed and is equally serviceable in every way.

The Electric Construction & Supply Company has just issued a handsome catalogue descriptive of this lamp.

Rosette Cut-Outs.

That there is room for improvement in cut-outs is evident from the fact that many devices of this class embodying new ideas are being brought out from time to time.

The accompanying illustration represents a '96 rosette cut-out that is being put on the market by the Gilmore Electric & Manufacturing Company, North Easton, Mass. Superiority is claimed for this cut-out in the connecting devices and in the perfection of details. The line wire connectors are made in the form of a clamp with rounded surfaces to clamp and slightly bend the wire. This form of connection makes an excellent contact without marring the softest wire, and the wire never slips or in any way causes trouble. It is claimed by the manufacturers that this is the only rosette in which the screw does not come in contact in some way with the wires. The connecting device on the cap is of the form of a hook, with a stiff notched spring to prevent the cap from coming off, except when given a quarter turn.



ROSETTE CUT-OUT.

This form of sliding contact always keeps the surfaces bright and clean, and allows the cap to be removed with facility, since no screw-driver is necessary in operation of removal. This last point is of great importance, especially where the rosette is located in dark or inaccessible places.

The arrangement of the fuse terminals is such as to permit of the longest fuse.

Inclined Elevator.

Among the many inventions which have reached a practical stage during the past year, one of the most noteworthy is the inclined elevator of the Reno Inclined Elevator Company, Mills Building, New York City. This invention is illustrated in the accompanying cuts, one of which shows the apparatus in practical operation at the Old Iron Pier, Coney Island, where it was tested during a two-weeks' run just before the

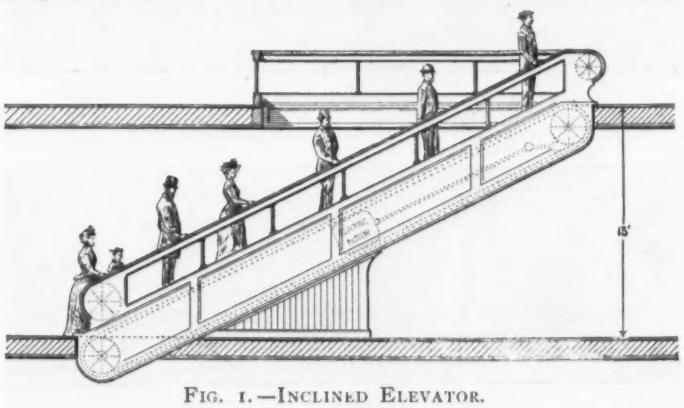


FIG. 1.—INCLINED ELEVATOR.

close of the last season. It is stated that the elevator carried over 75,000 passengers and that during the test not a single mishap occurred.

The operation of the elevator may be described as follows: The moving incline upon which the passengers step is practically an endless iron link belt of special construction passing around pairs of sprocket wheels at the top and bottom of the machine. The surface upon which the feet of the passengers rest consists of a series of longitudinal ridges having a corrugated upper surface which supports the feet comfortably and securely. In ascending as the passengers reach the upper end, their feet are slid upon a comb-like landing, while the ridges pass between its teeth so that it is not necessary for the person to necessarily step off at this point. It is stated that there is no danger whatever of being caught at the landing, and to test this feature cotton waste rags thrown upon the moving incline were deposited upon the comb landing without becoming entangled.

The incline has a speed of about 80 feet per minute, and the hand rail is movable at the same speed as the incline itself. The hand rail consists

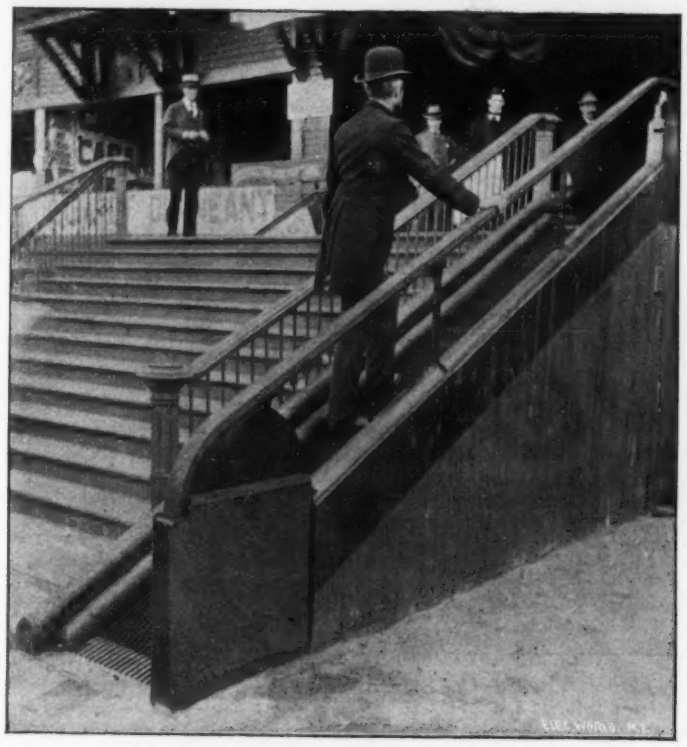


FIG. 2.—INCLINED ELEVATOR.

of an endless chain passing over sprocket wheels at both ends and concealed in the casings, as shown in our first illustration, Fig. 1. At the top of the links of the sprocket chain is riveted a molded rubber cover which presents a comfortable hold for the hand and makes it impossible for the fingers to rub against any of the stationary parts.

The elevator carried about 3000 passengers per hour, taking about 2¼ horse-power for the work, while when running without any load about one quarter horse-power was consumed. By using a motor running at a speed of 600 revolutions per minute directly connected to the usual form of worm gearing it was found to be a simple matter to attain a speed at the driving shaft of about 15 revolutions per minute, thus providing a very simple mechanical construction, positive in its action and almost noiseless. The elevator is under perfect control, and can be stopped and started by simply pressing a button.

In large stores, or any public places where crowds are to be handled, the elevator will be run continuously, but in smaller places, where there is not much traffic, it may be run only during the time needed to convey customers from one level to the other. With such a device as this in operation the second floors of many stores could be rendered available for business purposes which are not now used on account of the necessity of having to climb stairs. Another field of usefulness for these elevators would be at the stations of elevated railways and at terminal railway stations, where the waiting rooms are above the sidewalk level and a device of this sort for the patrons of the roads would no doubt be appreciated.

We understand that an installation of this machine will soon be put in operation in this city, where the interested public may judge for themselves of its merits.

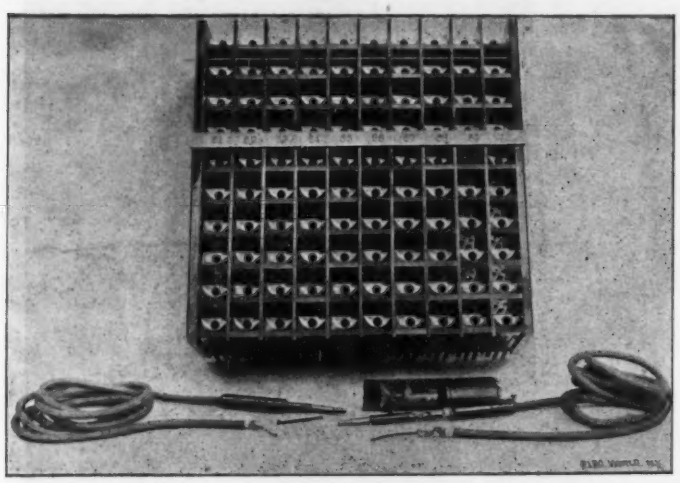
The Western Telephone Construction Company.

One of the most prominent competitors of the Bell Telephone Company is the Western Telephone Construction Company, of Chicago. By reason of the fact that the Bell apparatus is extremely good and thoroughly familiar to the public, it has become difficult for competing telephone companies to establish themselves, notwithstanding that the most important patents have expired. By sheer superiority of apparatus, however, together with efficient business management, the Western Telephone Construction Company has succeeded in putting its goods upon the market to such an extent that it is a large and prosperous concern. The company's instruments have special features, a description of which will prove of interest.

The telephone receiver is of the double-magnet type. The per-

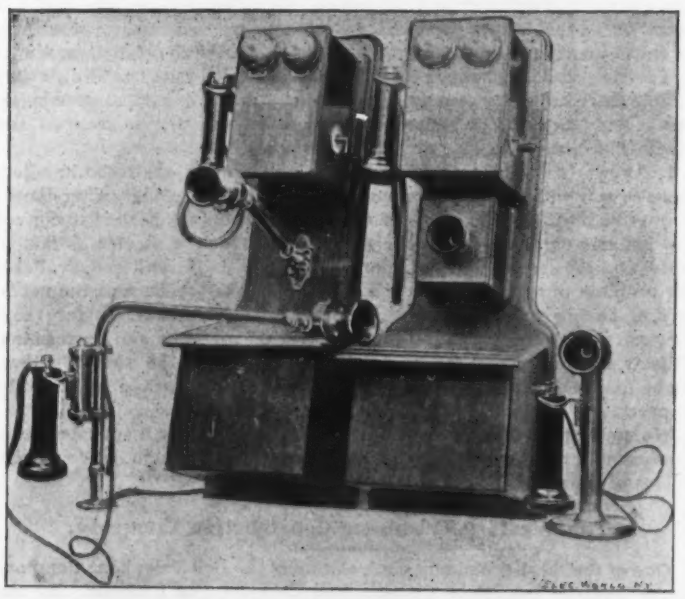
manent magnets consist of two straight steel bars placed with unlike poles together, which form a long horseshoe magnet. On the tips of the horseshoe are mounted soft pieces of iron on which bobbins are wound. The motion of the receiver disc therefore opens and closes the magnetic circuit, and the latter is so nearly closed that the very slightest motion of the receiver enormously varies the number of lines of force in the little bobbins. The receiver has a wonderfully clear and distinct articulation. The adjustment is obtained by screwing the magnet back and forward in the shell and clamping it by tightening up the screw at the end. This receiver has been adopted as standard on all the company's outfits.

The transmitter is no less interesting. It is of the granular carbon type and consists of a little cup-shaped receptacle in which a carbon button is secured by a single screw. On this carbon button is imprinted the words "Western Telephone Construction Company" in deeply scored letters. This inscription in such an obscure place, while apparently with-



Central Switchboard.

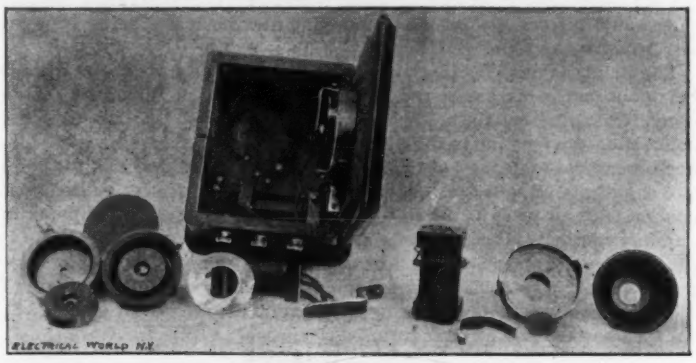
out any special design, in reality fills an important function; its object is a convenient method of roughening the carbon button so as to provide more points of contact. The transmitter is partly filled with a granular carbon and a carbon disc is placed over it. Then comes the outer clamp which holds the disc in place, and is provided with a screw nozzle to receive the hard rubber or electrose mouthpiece. A little round piece of screening is dropped into the socket and the mouthpiece is screwed tightly down upon it. This prevents curious persons from poking their fingers into the disc and fracturing it. The outside shell of the transmitter forms one contact and the screw which secures the carbon button in place forms the other. The transmitter is fastened into the door of



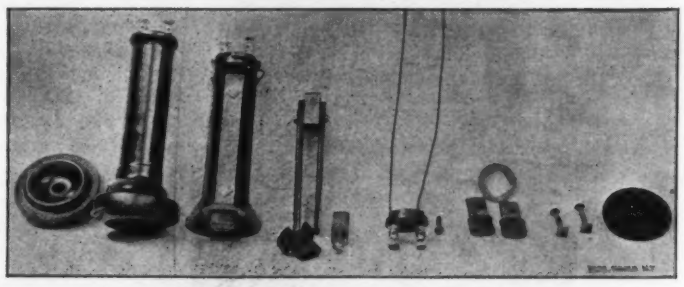
Types of Telephone Sets.

the receiver and is connected by little brushes, as shown, the object of this arrangement being to enable the transmitter to be turned about periodically by simply turning the mouthpiece, thus agitating the carbon and preventing its packing. The induction coil, which is of special design, is secured in the transmitter box in the usual way.

The magneto, another important part of the telephone, is constructed to ring through 10,000 ohms, but this is a very low rating; it never fails to ring through much higher resistance. Three steel magnets are bunched together, as shown, and constitute the field for the little armature. This armature is of cast iron, shaft and all, and fine wire is wound upon it in the deep shuttle-shaped groove provided for it, the wire being suitably connected to deliver alternating current at its terminals. A pinion and gear complete the mechanical connections. An ingenious fea-



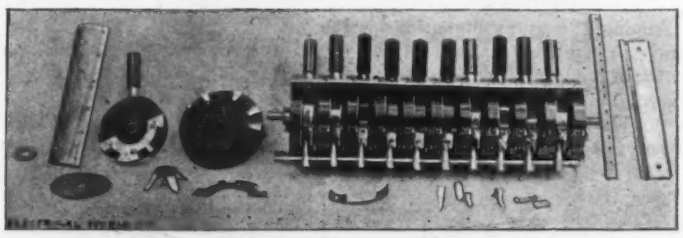
Transmitter and Parts of Same.



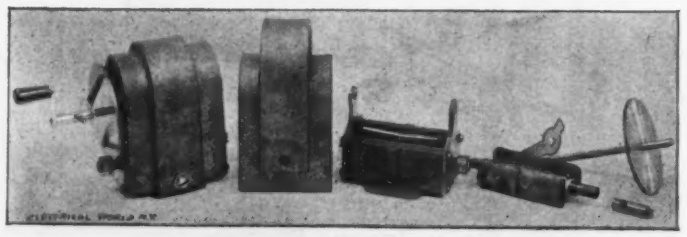
Receiver and Parts.

ture is the arrangement of the crank. It is mounted on a cylinder, which slips over the end of the driving shaft and is secured thereon with a pin. This pin moves in a spiral slot, and as the crank is turned it advances inward till the end of the slot is reached. This action makes the proper contacts for ringing up the line, but the moment that the handle is released the spring on the front of the gear wheel throws the handle back to its original position and the contacts are cut out. It is then only necessary to take down the receiver to begin conversation.

There is also shown a number of different sets designed for various uses and different situations. On the right hand is a desk set with a swinging arm, the induction-coil being placed in a little cylindrical case on the side of the upright. The transmitter is of the usual type, and is



Parts of Operator Switch.

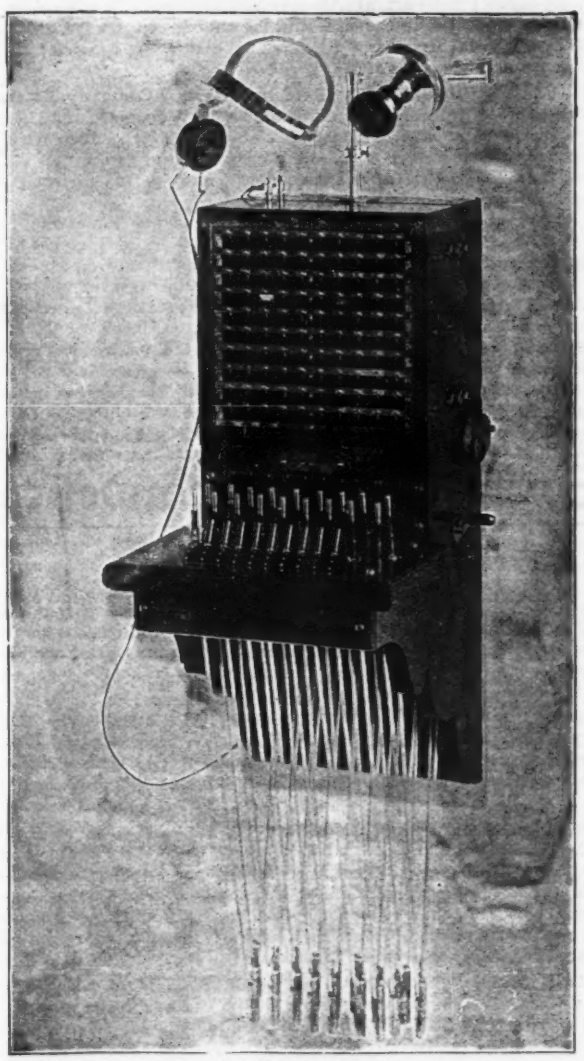


Magneto Parts.

provided with a universal joint so as to be readily adjusted to the height of the speaker. The next is a set with the adjustable transmitter in position; the third is the familiar wooden set which has been standardized through usage and is often called for; the last is a little desk set unique for compactness and convenience.

These instruments are thoroughly well made and no pains are spared to make them the best of their kind.

While containing many improvements and applications of ingenious invention, the Western Telephone Construction Company's transmitting and receiving instruments are by no means so striking in their novelty as the switchboard. The various parts of the switchboard are illustrated, one figure showing the completed board. Hard rubber is formed into a box of many compartments, resembling the pasteboard boxes made for packing eggs; in fact, this part of the board is often called the "egg case." In each of these compartments is placed a socket to receive the jack plug and and a magnet and drop. When a subscriber rings up, the drop falls exactly over the hole in which the plug is to be thrust, and when the operator makes connection that motion necessarily restores the drop. This arrangement of having jack plugs and drops together not only ensures great convenience in their manipulation but makes the board smaller than any other now made. In the front of the board is a switch of many levers, each section of which controls a section of the switchboard. Each of these little levers has four positions. One, the off position, 2, the resulting position, and 3 and 4 the calling positions. In long boards there are supplementary plugs by means of which one operator can communicate with another. One operator can always reach three boards, the one in front and the one on either side, the cords of the plug being long enough to make connection.



SWITCHBOARD.

If, however, a call is received for a line on a board beyond the operator's reach, she simply plugs into one of these auxiliary holes and signals the operator at the proper board to make the desired connection.

The Western Telephone Construction Company has reached its present degree of prosperity largely through the business ability and inventive genius of Mr. James E. Keelyn, the president. Messrs. George F. Stitch, M. B. Kennedy, I. Baumgartel and William A. Bisland are the other executive officers.

The Covering of Insulated Wire.

The name of Buchanan & Lyall, New York, which is very familiar in the tobacco industry, has been for some time identified with the manufacture of jute yarns on a large scale. Inasmuch as the finer of these yarns are largely used for the covering of insulated wire, a brief account of their manufacture will be of general interest.

The Buchanan & Lyall jute mills are located in Brooklyn, N. Y., and are about 200 feet long by 70 feet wide and three stories in height. On the lower floors the cruder processes are carried on, but as the material approaches the upper floors it comes more and more nearly to the end of its manufacture. The raw material is crude jute and is received in heavy bales, such as is shown in the foreground of Fig 1. These bales are taken apart and soaked in oil and water, so as to make the jute flexible, or as it is technically called, "mellow." The jute then passes through a long machine which is nothing more than a series of rollers. This machine is 20 feet long and a view of the same can be seen in Fig. 1. This operation tends to make the jute still more pliable. It is then done up in bundles of 15 pounds and in that shape is fed to the carding machines. The jute is carded twice and an automatic counter registers once for

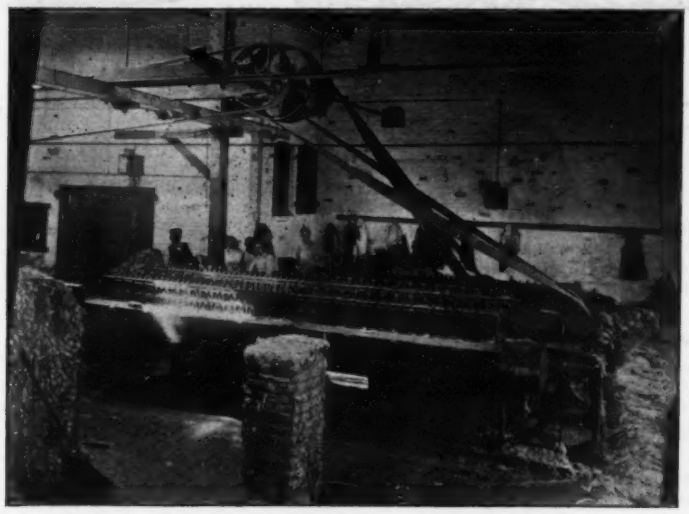


FIG. 1.—MANIPULATING JUTE.

every 30 pounds of jute that passes through the machine. This double carding makes the fibres parallel and delivers the jute into long, fluffy coils, when it is ready for the drawing machines. The long coils from the carding machines are fed in the rollers and passed through a comb or heckle which still further tends to strengthen the fibres. It then passes through two sets of rollers whose velocity ratios differ by a certain amount. In fact from the moment the jute enters the cards it is frequently drawn out in this manner so as to make the resulting coil longer and closer. The first card stretches the jute in the ratio of 11 to 1. The second card in the ratio of 18 to 1. The first drawing-frame in a ratio of 6½ to 1, and the second drawing-frame (there are two) in a ratio of 7 to 1. After leaving the drawing-frame it passes to the roving-frame which stretches it 8 to 1 and winds it into a very coarse yarn upon wooden bobbins. Fig. 2 illustrates the room containing this machinery. The roving machines are in the foreground and the carding machines are in the rear. When the jute is spooled from the roving-frames it is sent up-stairs to the spinning-frames, which reduce the yarn in diameter and increase it in length still more, and twist it so tightly that the fibres hold each other very strongly. The finished product is then wound into balls and into cylindrical rolls known as "cowens" and in that state it is shipped to

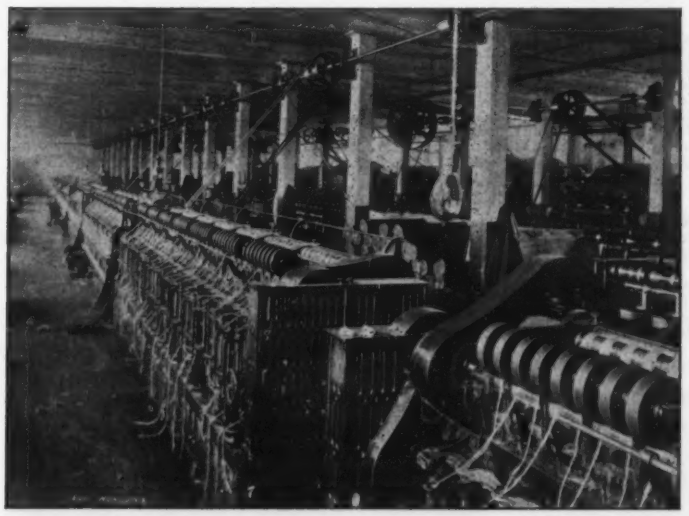


FIG. 2.—MACHINERY ROOM.

consumers. All of the apparatus except that which manipulates the crude jute is operated by women and girls, and it is surprising how rapidly they can adjust the machinery and how thoroughly they seem to understand its complications. They are schooled in this when very young, and women in charge grow up from young children who are first employed. The factory is a very extensive one.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Oct. 31, 1896.

ELECTRICAL STOCKS remained practically steady, slight changes being recorded in few instances. Edison Illuminating, of New York, is stronger, 94 being bid, against 92½ at the close of last week. General Electric is a fraction higher, as are also Westinghouse, common and preferred. In the bond list General Electric debenture 5s advanced half a point.

TELEGRAPHS AND TELEPHONES.—American Bell is 1⅜ lower than it was at the close last week, 203½ being bid, and 205 asked. American District and Commercial Cable remain at unchanged quotations. Erie Telephone shows a fractional increase, and New England Telephone is recorded with a 2 per cent. rise. Western Union is a trifle lower than it was at last week's close, being quoted at 84⅝ bid, holders asking 85.

TRACTION.—The general list of strict railway shares remains about steady. Among the few striking changes may be noted Buffalo Street Railway which experienced a substantial rise, amounting to 3 points. Hestonville suffered a decline of an equal amount; West End common and preferred closed at a slight gain over last week's closing prices. Street railway bonds are steady and unchanged.

DIVIDEND.—The New England Telephone & Telegraph Company has declared a regular quarterly dividend of $1 25 per share, payable on Nov. 16.

RAPID TRANSIT BONDS.—City Treasurer Turner, of Boston, on Oct. 29 opened bids for $1,000,000 worth of City of Boston, 4 per cent. 40-year registered rapid transit bonds, secured by a sinking fund. The bids varied from 103.52 to 105.555, but all were rejected. Mr. Turner, it is reported, will take no further action in the matter until the money market becomes more normal.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	..	..
Edison Electric Ill., New York	100	94	95
" " " Brooklyn	100	88	93
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	27½	27¾
Electric Storage, pref	100	29⅛	30
General Electric	100	29	29⅛
General Electric, pref	100	64	67
Westinghouse Consolidated, com	50	23	26
" " pref	50	49¼	50

BONDS.

Edison Electric Ill., New York	105	..	106½
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	90	..

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	203½	205
American District Telegraph	100	*20	30
American Telegraph & Cable	100	90	91½
Central & South American Telegraph	100	124	127
Commercial Cables	100	140	..
Erie Telephone	100	61⅝	..
New England Telephone	100	96	..
Postal Telegraph-Cable	100	78	80
Western Union Telegraph	100	84⅝	85

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	16⅞	17
Brooklyn Rapid Transit		19¾	20¼
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	69	71
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	39	41
Hestonville	100	45	49
" pref		..	62½
New Orleans Traction	100	7	9
" " pref	100	35	45
North Shore Traction	100	21	24
" " pref	100	72	75
Rochester St. Ry	..	16	18
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	103
Union Traction, rcts $10 pd	.	12¾	13
West End, Boston	100	67½	67¾
" " pref	100	89½	90
Worcester Traction	100	16	19
" " pref	100	88	92

BONDS.

Brooklyn Rapid Transit 5s. 1945	100	73	..
Buffalo St. Ry. 1st con. 5s	100	105	*107
Cleveland Elec. Ry. 1st mtge 5s	100	100	*103
*Columbus St. Ry. 1st 5s	100	90	*95
Rochester St. Ry. 1st 5s	100	..	98
Union Railway (Huckleberry) 1st mtge 5s		100	*103
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest.

EARNINGS FOR SEPTEMBER.—The report of the Edison Electric Illuminating Company, of Brooklyn, for September shows gross earnings $63,551.28, an increase of $6,098 32 as compared with September last year. Operating expenses $36.796.72. an increase of $6128.14. After deducting interest and other charges $18,587 89 is left available for dividends. For the nine months ending Sept. 30, the net earnings of the company were $219,056.03. an increase of $71,198.39.

THE ERIE TELEGRAPH & TELEPHONE COMPANY.—A quarterly dividend of 1 per cent. will be paid on Nov. 16. The statement of the company for the quarter ending Sept. 30 shows gross receipts, $306,422.61; gross expenses, $176,248.65; net earnings, $130,173.96; dividends, $117,662.50, leaving a surplus of $12,511.46. For the nine months ending Sept. 30, the gross income was $880,295.79; gross expenses, $515,769.17; net earnings, $364,526.62; dividends, $339,162.50, leaving a surplus of $25,346.12.

FINANCIAL REPORTS.—The Paterson Railway Company, Paterson, N. J., reports gross earnings for September of $26,639, a decrease of $3,836 as compared with the same month of last year, and net $10,394, a decrease of $4,717. For the nine months ending Sept. 30 the gross earnings were $245,489, an increase of $22,607 as compared with the corresponding period of last year, and net $103,065, an increase of $8,819.

The Union Railway Company's report for the quarter ending Sept. 30 shows the following results: Gross earnings, $155.511, an increase of $20,135 as compared with the corresponding quarter of 1895; operating expenses, $75,499, an increase of $929; net earnings, $80,012, an increase of $19,206. After deducting charges the surplus is $48.322, an increase of $19,194, as compared with last year's corresponding quarter.

The Scranton Traction Railway Company, Scranton, Pa., reports gross earnings for September of $31,588, an increase of $2593 as compared with the same month of last year, and net $13,430, a decrease of $3141. For the three months ending Sept 30 the gross earnings were $96,561, an increase of $10,312 as compared with the corresponding period of last year, and net $42,674, a decrease of $3837.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Nov. 2 1896.

NEW YORK AND BROOKLYN TUNNEL.—The Railroad Committee of the Brooklyn Board of Aldermen has reported favorably on the application of the New York & Brooklyn Tunnel Company for a franchise to construct a tunnel between the two cities.

NATIONAL BOARD OF FIRE UNDERWRITERS.—The Electrical Bureau of the National Board of Fire Underwriters, New York, has issued its quarterly fire report No. 13, dated Oct. 10, 1896. The report contains illustrations of four characteristic burn-outs. The next fire report will be issued Jan. 10, 1897.

DISSOLUTION OF THE EXPOSITION COMPANY.—The National Electrical Exposition Company, 136 Liberty Street, through its directors, Messrs. George F. Porter, Edward F. Peck and others, has applied to the Supreme Court for the voluntary dissolution of the company, and Justice McLean has set down the order to show cause for Feb. 1, 1897. The object of the company having been accomplished, there is no longer any necessity for continuing its corporate existence, hence the application.

PARLOR CARS IN REGULAR STREET RAILWAY SERVICE.—The Brooklyn Heights Railway Company has inaugurated a feature on its newly opened Flushing line which will probably be appreciated. The company proposes to establish a regular parlor car service between Flushing and Brooklyn, and on Tuesday and Friday of each week parlor cars will be run on schedule time. Seats will be assigned to passengers in a manner similar to that now done on parlor cars on steam roads and the street parlor cars will carry only their seating capacity. A porter will be in attendance to look after the wants of the passengers. For this extra service additional charge will be made. The regular rate between Brooklyn and Flushing is 10 cents and the special charge for seats on the parlor car between the two cities will be 15 cents.

NEW LIGHTING FACILITIES.—The section of the city lying between Fifty-ninth and 125th Streets has been lighted in a manner unsatisfactory to the residents thereof. For the purpose of effecting an improvement in this direction the West Side Electric Company has been incorporated and has applied for permission to construct subways along West End Avenue and thence to points on the Western Boulevard, the intention being to ultimately construct a subway on the last-named thoroughfare. Up to this time no effort has been made to supply this district with electric light. The power-house of the new company will be located near the North River, and work on the same will be commenced shortly. The subway construction work has already been started on West End Avenue between Seventy-second and Eightieth Streets.

SUPERINTENDENT SMITH EXONERATED.—The Fire Commissioners have dismissed the charges of fraud and incompetency brought against Mr. J. Elliott Smith, superintendent of fire alarm and telegraph of this city, and Mr. Smith has been reinstated. Among the charges brought against Mr. Smith were these: Accusing him of fraudulent acts in preparing contracts and specifica-

tions; of conspiracy to furnish supplies to the Fire Department at exorbitant rates; of conspiracy with various persons to defraud the city in the purchase of supplies; of conspiracy in the preparation of contracts, and of incompetency in permitting the fire-alarm system to deteriorate. The charges were dismissed, and in the opinion of the majority of the Commissioners who voted in favor of Mr. Smith and his reinstatement, it was stated that to prove charge eight, which related to the condition of the system, it would be necessary to show conclusively that either the superintendent made installations at a time when he could have obtained superior apparatus, or that he maintained the present apparatus after its inefficiency had been demonstrated, and when the necessary funds and the orders of his two superiors sanctioning such change could have been obtained. These things had not been proved, and, taking into consideration all the facts in the case, they find no room for hesitation, and have reached the conclusion that the fire telegraph service of this city, while undoubtedly susceptible of improvement, is to-day in a high degree of efficiency under conditions of difficulty not obtaining in any small city in the country, and that said efficiency is due to the professional skill and faithful and unfailing attention to duty of the superintendent of the telegraph service. They find no evidence of dishonest intent and unprofessional motive. The charges are therefore dismissed and the superintendent is restored to duty.

BUFFALO AND NIAGARA FALLS NOTES.

BUFFALO, N. Y., Oct. 30, 1896.

POWER AT THE CHEMICAL CONSTRUCTION PLANT.—The chemical construction plant, where chloride of potash is manufactured, is the only plant on the Power Company's land that is not operated at night. It uses 500 horse-power of electricity, and will soon use a great deal more.

TONAWANDA POWER DISTRIBUTION COMPANY BOOMED.—A sub-power company is being formed by New York capitalists together with some local men to receive and distribute the power from Niagara Falls lines to the consumers at the Tonawandas. The company will soon be ready to make the contracts for power.

ROYAL VISITORS AT THE POWER HOUSE.—Prince Hilkoff, of Russia, was a visitor at the Falls last week. This week Louis of Savoy, the Duke of Abruzzi, could hardly have had better weather to view the wonderful works of both Nature and man. A special train of three cars was provided by the Gorge Railway Company to enable the distinguished foreigners to see the sights of Niagara.

THE BUFFALO TRACTION COMPANY.—Mr. Herbert B. Bissell is urging the work of obtaining consents from the property owners for laying tracks and installing trolley lines in the streets of Buffalo. He says they are getting consents now, but that in about one month they will probably have all the consents in on the first 30 miles of line, and then they will begin operations, rushing the work as fast as possible.

POWER AT THE CARBORUNDUM WORKS.—At the Carborundum Works 1000 horse-power of electricity is now used in the plant, and enlargements are soon to be made that will call for 10,000 horse-power. This company is made up of Pennsylvanians and $300,000 is invested in the plant. In the plant are five furnaces, each one using 1000 horse-power. The current is put on one furnace at a time. After the current has been on 24 hours it is turned off and the molten mass is allowed to cool. This usually consumes 48 hours. The current is always at work. It is moved along from one furnace to another.

THE POWER PLANT.—The big power plant in this city, as the time draws near for the turning on of the current that is to go from it to light and heat Buffalo, as well as to drive the wheels of industry of that city, becomes the magnet that attracts the attention not only of people of this section of the United States, but of all the world as well. At the present time the three transformers and two dynamos are being put to their utmost to generate enough electricity to run the aluminum, carborundum, carbide electro-chemical, chemical construction, Dobbie & Stuart's, Buffalo & Niagara Falls Electric Light and other plants.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., Oct. 30, 1896.

ACTIVE BUSINESS.—The Hartford (Conn.) Machine Screw Company's works gave evidence, upon a recent visit of the writer, of unusual activity, due to increased orders, and President Fairfield was correspondingly happy. This company has earned an enviable name in the electrical trade for the excellence of its screw manufactures.

MR. SEARS B. CONDIT, manager of the well-known L. A. Chase Company, of Boston, has returned from the Street Railway Convention at St. Louis, where he was particularly successful with the "Horseshoe Rail Bond," scoring as well some good points generally for his company. Mr. Condit is one of the most energetic and aggressive young men in the electrical business, and always makes a good record for his particular line of work and specialties.

MR. GEO. C. EWING, 620 Atlantic Avenue, Boston, Mass., has recently received some good Winter orders for electric railway equipment, and anticipates after election an especially active business. Mr. Ewing attended the recent Street Railway Convention at St. Louis, where he met many of his old friends and added greatly thereto by making new friends. Mr. Ewing, being secretary of the Neal Electric Headlight Company, represented at the Convention this excellent device, which has already received such liberal adoption by street railways.

WEDDING ANNIVERSARY.—Mr. C. S. Haley, of the New England office of the General Electric Company, celebrated on the evening of Oct. 17 at his magnificent residence, "Haleyholme," Allston, Mass., the 25th anniversary of his marriage, which attracted a large number of the friends of his good wife and himself, none of whom failed to bring with them substantial evidences in honor of the event and their personal esteem. But few men engaged in the electrical business can boast of a larger circle of friends or a stronger business clientage than can Mr. Haley. An enviable reputation certainly, and due entirely to his strong business integrity and other noble characteristics of heart and mind.

THE STANDARD THERMOMETER & ELECTRIC COMPANY, of Peabody, Mass., has just issued its new catalogue, No. 31, and illustrating as it does its various types of Upton arc lamps for all circuits, it will be found of especial interest. This company is doing a splendid business, and its new alternating lamp and series of inverted lamps are commanding at present especial attention and good orders. Electrical engineers and contractors are particularly pleased with Upton arc lamps because of their simplicity of operation and mechanism. This company also manufactures and keeps constantly in stock a complete line of wattmeters, thermometers, telemeters, steam traps and other mechanical and electrical devices.

ERICSSON TELEPHONES.—Messrs. Williams, Couch & Whitman, of Boston, Mass., have secured the sole selling agency for the United States of L. M. Ericsson & Co.'s, Stockholm, Sweden, coal grain microphone, through Messrs. Smith & Patterson, of New York, L. M. Ericsson & Co.'s sole American agents. They are also selling agents for the Ericsson complete telephone apparatus. Messrs. Williams, Couch & Whitman are one of the largest and most successful handlers of telephones in the United States and the Ericsson Company is to be congratulated in securing such experienced gentlemen to handle their goods. The trade may depend upon receiving the best of treatment at their hands. This firm is now locating in new and spacious quarters at 196 Summer Street, where it will have abundant room for its business and manufacturing departments.

CANADIAN NOTES.

MONTREAL CAN., Oct. 30, 1896.

PARRSBORO, N. S.—Dr. J. R. Smith has secured from the town certain privileges to put in an electric light plant.

KEEWATIN, ONT.—The Keewatin Power Company is preparing to utilize the water-power secured through its dam at this place by making a contract for the transmission of 5000 horse-power to Winniepeg. The company is prepared to enter into a contract for constructing the necessary works in connection therewith.

MONTREAL, QUE.—Work on the Montreal Park & Island Railway Company's extension to Lachine is progressing so rapidly that it will probably be completed in less than a month. Negotiations are now in progress for a working agreement with the Montreal Street Railway Company in order that a through service may be given to Lachine from the centre of the city.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Oct. 24, 1896.

PREPAYMENT METERS.—A modest little company has just come before the public asking it to finance an ingenious and simple mechanism to be fitted to electric meters. In this country prepayment meters have proved a veritable gold mine to the gas companies, and it is possible that the idea may prove equally profitable in the case of electricity. It is, however, to be remembered that the gas companies have up to the present tapped a much lower social stratum than the electric supply companies, and unless a tolerably lower social stratum *is* tapped, the prepayment meter has no attractions. Of course, if some of the palatial artisans' dwellings now running up in various parts of London are wired for the electric light, as well as "*piped*" for gas, it would be a big field for the electric prepayment meter.

ELECTRIC TRACTION IN BIRMINGHAM.—Subscriptions are being invited this week for £200,000 4 per cent. first mortgage debentures of £100 (issued at £102) and 24,000 accumulative 5 per cent. preference shares of £5 each (issued at £5 4s.), in connection with a concern known as the City of Birmingham Tramways Company (Ltd.) The capital of the company is £1,000,000 sterling, £400,000 being 5 per cent. preference shares, and £600,000 ordinary shares, with £500,000 first mortgage debentures. Of the ordinary shares 60,000 have already been applied for and allotted at par. The company acquires the whole of the railways in the City of Birmingham and neighborhood, and was formed to purchase the existing railway company and to work a "concession" granted to Messrs. Mackenzie & Ross, of Canada, which involves the electrical equipment of the whole of the railways in Birmingham. The Birmingham railways, I may mention, have hitherto been worked on no less than four different systems of traction, viz., horse, steam and cable traction, and accumulator cars.

General News.

NEW INCORPORATIONS.

THE WEST SIDE ELECTRIC COMPANY, New York, N. Y., has been incorporated by W. A. Mitchell, Brooklyn, E. C. Simonson and C. V. E. Gallup, New York City. Capital stock, $25,000.

THE PHŒNIX ELECTRIC LIGHT COMPANY, Kansas City, Kan., has been formed with a capital stock of $300,000, by W. S. Beard, M. A. Stewart and R. B. Armstrong, Kansas City, Kan.

THE COMSTOCK TELEPHONE COMPANY, Troy, N. Y., has filed articles of incorporation. It is proposed to connect Truthville, North Granville, Comstock's and West Granville by telephone. Capital stock, $500.

THE ORIENT ELECTRICAL COMPANY has been incorporated at Youngstown, O., with a capital stock of $25,000. The promoters are Lucius E. Cochran, George M. McKelvey, Wick C. Cans, Mason Evans and A. B. Mannix.

THE GREATER NEW YORK SIGNAL COMPANY, New York, N. Y., has been incorporated with a capital stock of $5,000. The incorporators are Jacob Fleischhauer, Allen Lexow, Charles K. Lexow, of New York, and others.

TELEGRAPH AND TELEPHONE.

RUSHVILLE, IND.—The Central Union Telephone Company has discontinued its Rushville office.

WOONSOCKET, R. I.—The Providence Telephone Company will soon erect a 50-wire cable on Railroad Street.

TECUMSEH, NEB.—The Nebraska Telephone Company has applied to the City Council for a franchise to establish its system in this place. It agrees to begin work within 30 days after the franchise has been granted.

CHICAGO, ILL.—Mr. H. B. Stone, president of the Chicago Telephone Company, has issued orders authorizing physicians to use the automatic or pay telephones for communication with the Health Department free of charge.

TELEPHONE SUIT.—Information comes to us from Philadelphia to the effect that the Western Telephone Construction Company, of Chicago, has filed a bill in equity against the Philadelphia Standard Telephone Company, the Union Traction Company and others, alleging infringement of patents.

VIROQUA, WIS.—Steps are being taken looking to the extension of the Crawford County telephone system to this city. Permission has been granted by the Council for the erection of poles, etc., and when the work is completed this town will be in telephonic communication with all the State of Wisconsin.

TELEPHONE OUTPUT.—The instrument statement of the Bell Telephone Company for the month ended Oct. 20, shows gross output of 14,766 instruments; returned 7252; net output 7514. The total number of instruments outstanding at date is 763,898, and at the same time last year the number was 657,883.

ELECTRIC LIGHT AND POWER.

BLUFFTON, O.—The erection of an electric plant is under consideration.

CHAMPAIGN, ILL.—A new electric light company is to be organized at Champaign.

COXSACKIE, N. Y.—Parties have been in Coxsackie trying to locate an electric lighting plant.

NAPPANEE, IND.—The Board of Trustees are about to increase the capacity of the incandescent light system.

SUMNER, IA.—At a recent vote on the question of electric lights the proposition was carried by a large majority.

GRAND HAVEN, MICH.—A resolution was passed authorizing the Board of Public Works to advertise for bids to erect buildings for electric light plant.

ATTICA, O.—The project to establish an electric light plant in this place is being considered by the citizens. The town at present is lighted by kerosene lamps.

BARNESVILLE, GA.—Bonds are to be issued for the erection of an electric light plant for the City of Barnesville and for building an armory and auditorium for Gordon Institute.

DEMOPOLIS, ALA.—The city wants bids on the erection of an electric light plant with two 75-hp boilers; one 100-hp engine, five miles of wire, etc. Address J. G. Chisolm, City Clerk, for further particulars.

TAUNTON, MASS.—At a special meeting of the Common Council a few nights ago the proposition to build a municipal electric light plant was favorably considered, and the question will be decided by the voters.

EAGLEVILLE, N. Y.—The electric light plant of the Morrisville Electric Light Company, which was located at this place, was destroyed by fire on Oct. 26, entailing a loss of about $40,000. There was no insurance on the property, and as there had been no fire in the building since Saturday, incendiarism is suspected.

THE ELECTRIC RAILWAY.

PORTSMOUTH, N. H.—An electric railway from Portsmouth to Rye is proposed.

ST. LOUIS, MO.—The South Electric Railway Company is considering the extension of its lines.

AUSTIN, TEX.—It is stated that the Austin Street Railway is to be extended into the suburbs.

COLUMBIA, S. C.—Important extensions will be made by the Columbia Electric Railway Company.

NEW CASTLE, PA.—The New Castle Electric Street Railway Company will extend its system to Croton next Spring.

NEW HAVEN, CONN.—The new Haven Street Railway Company is to make some extensive changes in its tracks at Morris Cove.

WINOOSKI, VT.—The Winooski & Burlington Horse Railway Company is planning to extend its line along the lower road to Winooski.

BANGOR, ME.—Construction on the Bangor, Hampden & Winterport electric railway will be begun at once, and two or three miles of track will be laid this Fall.

LANCASTER, PA.—A strong effort will soon be made to get the traction company to extend its East Chestnut Street line to Broad Street and thus make its belt line more serviceable.

SCRANTON, PA.—The Scranton Traction Company contemplates the installation of a new 700-hp engine. This additional engine will increase the total horse-power of the station to 1200.

WEST CHESTER, PA.—Representatives of the Pottstown & West Chester Railway were at Lionville and vicinity making surveys in that section over which the proposed new line is to pass.

UTICA, N. Y.—The street railway tracks in Lafayette Street will be extended up Lafayette and through Whitesboro Street, connecting at Columbia Square with the tracks running up Columbia Street.

OBITUARY NOTE.

WILLIAM A. HARRIS, the manufacturer of the Harris-Corliss engine, died at the residence of his son, Fred Harris, at Providence, R. I., on Oct. 29, at the age of 62 years.

Trade and Industrial Notes.

K. McLENNAN & CO., Marquette Building, Chicago, the manufacturers of Gale's commutator compound, request all users of generators and motors, who are troubled with sparking and cutting, to send for free samples of their compound.

THE MOSS CARBON HOLDER.—In our last issue we made a brief reference to a new self-centering carbon holder just brought out in Syracuse, N. Y., and for the information of all those interested, we wish to state that communications addressed simply to the "Moss Carbon Holder," General Delivery, Syracuse, N. Y., will receive prompt attention.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has a contract for a car barn and shop building for an electric road at Port au Prince, Hayti. These buildings will be of steel throughout, having a steel skeleton framework covered on the sides and roof with corrugated iron. The shop is 33 x 70 feet, and the car barn 40 x 160 feet. This building is only one of many which have been gotten out by the Berlin Iron Company for export to foreign countries during the past few months.

THE ELECTRIC APPLIANCE COMPANY is meeting with large success as the general Western agent for the Taunton Copper Manufacturing Company, and is now carrying a large and complete stock of the Taunton Company's celebrated bare copper wire. The Electric Appliance Company states that its customers seem to appreciate the advantage of having a complete stock of bare copper wire carried in Chicago, from which they can draw in large or small quantities, as their needs demand.

REPORTS DENIED.—We are informed by the Western Telephone Construction Company, Chicago, that the reports recently circulated to the effect that certain telephone companies had sued the Western Telephone Construction Company upon switchboard patents, are totally untrue. It is stated that an attempt had been made to confound the Watson hook switch patent with switchboard patents. The company has never been sued upon a switchboard patent, so it informs us, and it claims that its switchboards are absolutely free from infringement of patents of others.

AMERICAN MACHINERY ABROAD.—Herr B. Schuchardt, senior member of the firm of Schuchardt & Schutte, Berlin, Germany, and Vienna, Austria, accompanied by his wife and H. Geif, his chief engineer, recently visited the works of Messrs Gould & Eberhardt at Newark, N. J., and inspected the shops thoroughly. Mr. Schuchardt represents large importers of machinery on the Continent, who import especially American products, and is the general agent for Gould & Eberhardt. Regarding the standing of American machinery abroad, Mr. Schuchardt said: "The demand for American machinery is constantly increasing, as the large European manufacturers look to this country for the latest and most advanced machinery."

NEW FIRM OF ELECTRICAL ENGINEERS.—Messrs. George H. Barrus and William S. Monroe have opened an office in The Rookery, Chicago, as mechanical and electrical engineers and experts. The firm is prepared to lay out and superintend the construction of steam and power plants, electric lighting and railway systems, steam heating plants, etc., and will bring to this work the best practice of the times, having always in mind the highest economy in cost consistent with economy in operation and satisfactory performance. They will also give personal attention to tests of boilers, engines and electrical apparatus and investigations in every line of electrical and steam expert work. Mr. Barrus is well known as an expert in steam engineering, particularly in the East, as he was located in Boston for 20 years. Mr. Monroe has been in business as mechanical and electrical engineer in Chicago for the past two years and is a man of considerable experience. The firm will carry on business in all the lines that naturally come within the scope of the professions of each member.

MICANITE INSULATION.—A very interesting addition to the existing data on insulating materials has recently been issued by the Mica Insulator Company of New York, Chicago and London, in the form of a collection of samples of the various insulating materials which it manufactures, together with the results of actual tests on these various materials attached to each sample. Results are given on tests of the necessary voltage to break down a given thickness of each of these materials, and also on the specific insulation resistance of the same. The figures given are the average of a large number of tests under various conditions, and are taken from the experiments of Messrs. Herrick & Burke, of New York. The Mica Insulator Company has realized that in order to fulfill the varied requirements of insulation it is necessary to manufacture various qualities and kinds of materials, as there is no one universal quality of insulation. Its samples cover a number of grades of "Micanite" insulation consisting of a number of combinations of mica, mica and cloth, and mica and paper of various degrees of flexibility. Also a number of grades of "Empire" insulation, which consists mainly of specially prepared and insulated cloth and paper. From a technical standpoint, the collection is very interesting, because it not only shows the various kinds of materials manufactured, but also is indicative of the advances that have been made in the preparation and manufacture of insulating materials, both from a mechanical and electrical standpoint, and the high degree of perfection that has been reached in this line of electrical industry.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67–71 Park Place, New York.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCT. 27, 1896.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

569,989. ELECTRIC MOTOR REGULATOR; W. A. Anthony, Newark, N. J. App. filed July 29, 1896. In combination, a multipolar motor and means for varying the strength of any pair or pairs of field-magnet poles.

570,009. RHEOSTAT; A. C. Binkey, Munhall, Pa. App. filed March 20, 1895. A rheostat having a single set of resistances provided with a single set of contact-plates, and a separate arc-shaped contact-plate, an arm arranged to move over said plates in either direction, and means for reversing the current through the resistance when the direction of movement of said arm is reversed.

570,013. GALVANIC BATTERY; R. W. Gordon, New York, N. Y. App. filed Oct. 14, 1895. The combination of a jar, a permeable negative element suspended therein and adapted to contain a depolarizing agent, and positive element and insulating supports for said positive element secured to the walls of the negative element and projecting therefrom, and interposed between and supporting the positive element.

570,019. WATTMETER; G. Hummel, Munich, Germany. App. filed Jan. 30, 1895. An alternating-current motor provided with a stationary field-magnet having pairs of internally-projecting field-magnet poles surrounded with field-magnet windings connected directly to a source of alternating-current supply, an additional field-magnet winding of higher resistance than the field-magnet winding and located in shunt relation thereto, and an induction device located in said shunt for shifting the current phase in combination with a rotary part consisting of a diamagnetic material, such as copper, and a fixed stationary part eccentric with said rotary part, said stationary part being of magnetic material, and both of said parts being located wholly in the inductive field of all the pole-pieces, whereby the inducing and induced effects are substantially the same.

570,028. END ELECTRODE FOR ELECTRIC POWER STORAGE BATTERIES; J. Langelaan, Cologne, Germany. App. filed Dec. 10, 1895. The combination in electric storage batteries, having positive and negative plates provided with active material, alternately arranged therein, of end plates having openings therein, and the plates intermediate the end section having unbroken surfaces.

570,034. INSULATOR; C. B. Martin and E. M. Hewlett, Schenectady, N. Y. App. filed Aug. 5, 1896. In an insulator the combination of a body of insulating material, a support therefor, a metal clamp for gripping the rail adapted to be slid upon the insulator when assembled and means preventing the clamp from lifting.

570,045. VALVE-CONTROLLING DEVICE; C. E. Ongley, New York, N. Y. App. filed Oct. 30, 1893. In a valve-controlling device, the valve consisting of a valve chest having inlet and outlet ports, and a valve stem having two heads to control said ports and two springs bearing with equal tension upon the valve stem heads in combination with a motor to operate said valves consisting of a cylinder having operative valves and piston rod and electromagnets in circuit having armature secured to the valve stem of said motor and means to control the circuit.

570,046. ELECTRIC SIGNAL FOR STREET-CAR CROSSINGS; C. A. Parrish, Jackson, Mich. App. filed Jan. 23, 1896. A signal apparatus comprising a circuit-maker adapted to be closed by contact of the trolley-wheel, a set of magnets, a circuit from the circuit-maker to the track or ground and including therein the signal wire and said magnets, circuit-terminals, a contact-lever with contact point and operated by the armature of the magnets to contact with said circuit-terminals when the trolley-wheel closes the circuit-maker, thereby closing the signal-circuit and re-energizing the magnets, a signal, a circuit from the feed-wire to the track or ground and including therein the signal, the magnets and circuit-terminals, a circuit-maker for stopping the signal and a shunt-circuit running to the track or ground and including the signal.

570,053. ELECTRIC ARC LAMP; G. C. Pyle, Indianapolis, Ind. App. filed Jan. 27, 1896. In an arc lamp the combination of a gravity-feed upper electrode, a lower electrode, telescoping springs to support said electrode and feed it upward and a solenoid to regulate the arc.

570,062. SIGNAL APPARATUS: J. G. Schreuder, Edgewood Park, Pa. App. filed May 21, 1896. The combination of a signal, mechanism for operating the signal, and lever connected to the signal and its operating mechanism, and mechanism independent of the signal-operating mechanism applied to the fulcrum of the lever for raising and lowering the fulcrum.

570,068. ELECTRIC SWITCH; S. A. Stewart, Waltham, Mass. App. filed March 12, 1896. In an electric switch the combination of an arm or lever carrying contacts and adapted to hold said contacts in circuit by a suitable spring, an electromagnet supported by a suitable frame, a rock-shaft supported by said frame, the armature arm fast on said rock-shaft and supporting the armature and provided with a projection or cam, another rock-shaft supported by said frame, a trip on said shaft bearing against said projection or cam and adapted to catch in a suitable projection extending from the arm or lever, and a spring of sufficient power to hold said trip in engagement with said arm or lever by the aid of the power of the magnet upon the armature, but of sufficient strength to support the trip in such engagement without the aid of said magnet.

570,072. TELAUTOGRAPH; G. S. Tiffany, Highland Park, Ill. App. filed Jan. 6, 1896. In a telautographic system, the method of operating two separate electromagnetic mechanisms over one line wire which consists in placing one of said mechanisms in the main line and the other in a local branch and causing pulsations of successively opposite polarity to traverse the main line and groups of pulsations of successively similar polarity to traverse the branch line, the main line mechanism being operated by the changes in polarity of the successive pulsations and the branch line mechanism being operated by the changes in the polarity of the successive groups.

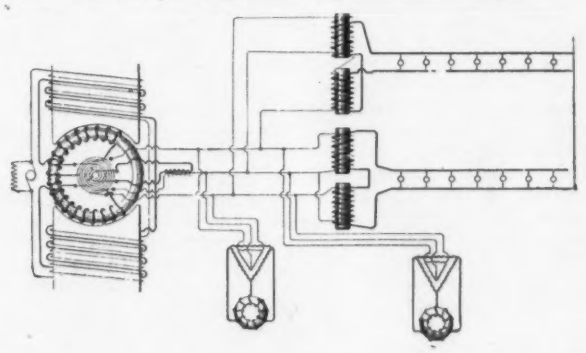
570,077. ELECTRIC HEATER; E. P. Wetmore and C. E. Roehl, St. Joseph, Mo. App. filed May 1, 1895. An electric heater consisting of the combination of an electric converter, having hollow secondary conductors thereon, and means for electrically closing each or all upon themselves, said means being provided with circuit-closers for opening and closing the primary conductor of the said converter.

570,078. TROLLEY FOR ELECTRIC RAILWAYS; W. M. Whiting, East Orange, N. J. App. filed May 5, 1895. In a trolley for electric cars, the combination with a trolley-arm and trolley-head secured thereto, and fingers on said head, of a pivoted trolley-carrier having a trolley wheel and means co-operating with said carrier to constantly and yieldingly force said trolley-wheel against the trolley-wire irrespective of the movements of the trolley-pole, the said fingers on the trolley-head being adapted to be brought against said carrier to act as stops.

570,089. SAFETY APPARATUS FOR RAILWAY CROSSINGS; G. Gibbs, Milwaukee, Wis. App. filed Dec. 4, 1895. In safety apparatus for railway crossings, the combination with an electric line, of a manually operated safety device for controlling the passage of cars thereon, a locking device for holding said safety device in a given position, a magnet controlling said locking device, an insulated section of trolley-conductor, and a conductor connecting said section through the winding of said magnet with the source of current supply.

570,112. TELAUTOGRAPH; G. S. Tiffany, Highland Park, Ill. App. filed June 7, 1895. In a telautographic receiving instrument, the combination of a friction clutch for transmitting power from the motor shaft to the receiving pen, and a magnet for controlling the position of said friction clutch, to determine the direction of motion transmitted in accordance with the movement of the transmitting pen, the parts of the clutch being in each of its positions held in contact by spring pressure.

570,118. SYSTEM OF DISTRIBUTION FOR ALTERNATING CURRENTS; C. S. Bradley, Avon, N. Y. App. filed April 3, 1895. A system of electrical distribution comprising a generator comprising a plurality of physically-differing alternating currents and a single-phase lamp-circuit supplied thereby through a transforming device provided with two magnetic circuits energized by two coils through which different current-phases are led, and discharging in common into the lamp-circuit, the phases being reversely applied to the transformer coils to bring the two E. M. Fs. operating on the lamp circuit-closer in phase.



570,118.—SYSTEM OF DISTRIBUTION FOR ALTERNATING CURRENTS.

570,119. ELECTRIC CAR MOTOR; C. S. Bradley, Avon, N. Y. App. filed March 30, 1896. The combination with the wheels and axle of a car-truck of an electric motor mounted upon a sleeve surrounding the axle, said sleeve being supported by the car wheels upon tangentially-arranged springs.

570,140. SECTION INSULATOR; L. McCarthy, Boston, Mass. App. filed Nov. 19, 1894. A section insulator, comprising side bars and end pieces, to which said bars are attached, the said end pieces having means for securing the ends of section-wires and being provided with deflecting portions which diverge laterally and rearwardly and also incline rearwardly.

570,165. ART OF LINING METAL TUBES WITH FIBROUS MATERIAL; E. T. Greenfield, New York, N. Y. App. filed March 2, 1896. One or more forming dies for giving to a strip of pliable or fibrous material, such as paper, a tubular form, means for heating said forming die or dies, in combination with means for driving the strip always in the same direction.

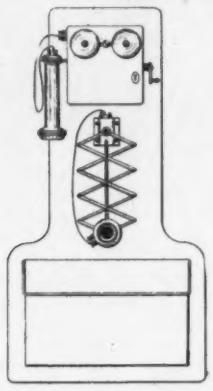
570,166. INSULATING JOINT FOR METAL OR ARMORED-CONDUIT TUBES; E. T. Greenfield, New York, N. Y. App. filed April 6, 1896. As a means for joining armored-conduit tubes, a collar which is interiorly screw-threaded at its opposite ends and provided with an interior thimble of insulating material, said thimble having V-shaped grooves at its opposite ends, and being adapted to receive under pressure the ends of the insulating linings as said conduit tubes are bound together by the screw-threaded collar.

570,167. METALLIC JUNCTION-BOX AND MEANS FOR UNITING METAL CONDUIT-TUBES THERETO; E. T. Greenfield, New York, N. Y. App. filed April 6, 1896. A junction box provided with an integral screw-threaded neck, a screw-threaded locking collar, and means for firmly gripping or holding a tube in place in alignment with said neck, said gripping means being adapted to exert a wedging action between the neck and the locking collar.

570,168. UNDERGROUND CONDUIT; E. T. Greenfield, New York, N. Y. App. filed May 11, 1896. In a subway or conduit a series of conduit tubes extending in a man-hole or to a point of distribution, each of said conduit tubes being provided with screw-threaded ends and corresponding screw-threaded locking nuts attached to short sections of insulating tubing, for cross-connecting said tubes.

570,169. CONDUIT TUBE; E. T. Greenfield, New York, N. Y. App. filed May 13, 1896 An armored conduit having an insulating lining composed either wholly or in part of a material which liquefies at abnormal temperatures, in combination with a non-combustible non-liquefying interior lining adapted to withstand temperatures greater than the fusing temperature of lead.

570,170. INSULATING JOINT FOR CONDUIT TUBES; E. T. Greenfield, New York, N. Y. App. filed July 25, 1896. As a means for uniting two or more conduit tubes, a pair of collars provided with locking bolts, said collars being so constructed as to constitute, when joined, an annular chamber around the ends of the tubes, in combination with an insulating annulus or ring which surrounds the ends of said tubes, and a mass of insulating material which fills the aforesaid annular chamber.



No. 570,204.—Adjustable Telephone Transmitter.

570,172. SNAP-SWITCH; A. B. Herrick, Jersey City, N. J. App. filed July 12, 1895. The combination, in a switch, of a pivoted blade, a single-snap blade, contacts on different sides of the pivot in position to co-operate with the same main blade and with the same snap-blade, contacts being entirely distinct from the main-blade contacts, so that the main blade will not be roughened by sliding over the small-blade contacts, and a spring connection between the main and snap blades for throwing the latter from its contacts on either of the different sides.

570,204. ADJUSTABLE TELEPHONE-TRANSMITTER; A. Gartner, Newark, N. J. App. filed Feb. 15, 1896. In a telephone service, the combination with the frame of a bracket projecting from said frame, a telescopic skeleton pivotally secured to said brackets and consisting of a series of sets of crossing arms pivotally connected at their centres and at their outer ends, the telephone-transmitter arranged at the free end of and at right angles to said skeleton, a loop or eye projecting from said transmitter, and a rod secured to the bracket and adapted to engage said loop or eye

570,212. CIRCUIT-BREAKER; A. J. Wurts, Pittsburg, Pa. App. filed Aug. 31, 1895. In an automatic circuit-breaker the combination with a latch for the movable member, and means for withdrawing the same comprising an electromagnet and its armature, of a magnet acting in opposition to said electromagnet to prevent accidental or premature withdrawal of the latch.

570,256. ART OF MAKING INTERIOR CONDUITS; E. Lavens, Brooklyn, N. Y. App. filed March 16, 1896. An improvement in the art of making interior conduits consisting in inserting a tubular lining formed of soft, pliable and resilient insulating material within a protective armor and then effecting close union of the armor and insulating lining by drawing down or otherwise reducing the diameter of the external tube.

570,258. FIRE AND BURGLAR ALARM; B. J. Lowman, Bridgeport, Ala. App. filed Dec. 27, 1894. The combination of a push button, a supplemental or second push-button, adapted to engage with the first-named button, said supplemental button being adapted to be moved independently of the other button and a spring arranged to hold the two buttons out of engagement with one another and adapted to permit the operation of the supplemental button.

570,310. ELECTRICAL APPARATUS; J. F. Kelly, Pittsfield, Mass. App. filed June 23, 1896. In an electrical apparatus having when in operation a varying magnetic flux, a laminated iron core traversed by said varying magnetic flux having in its composition an alloy preventing hysteresis growth.

570,328. ELECTRIC RAILWAY; A. Norman, Toronto, Can. App. filed June 22, 1895. In an electric railway, the combination of a supporting rail upon which the cars run, the rails being formed in sections which are insulated from each other, and with a central cavity, a main conductor mounted with the cavity of the said rail, insulating supports for the conductor also arranged within the said cavity, and means for bringing the main conductor and the sections of the rail into electrical engagement successively.

570,373. ELECTRICALLY ACTUATED SWITCH MECHANISM; W. S. Browne, Brooklyn, N. Y. App. filed Dec. 5, 1805. In an electrical railway system, comprising a main line and a branch line, a switch-point at the junction of the branch line with the main line, electrically operated devices for moving the switch-point in opposite directions, two series of contacts supported by the trolley-wire, one contact of each series being adjacent to the switch-point, the contacts of one series being of less width than and being arranged at different elevations with respect to the contacts of the other series, circuit connections between the contacts and the devices for operating the switch-point, and contacts carried by a car for engaging successively with the first-named contacts and operating first to place or hold the switch-point in engagement with the main track line, and then operating to move the switch-point into engagement with the other branch line.

570,406. AUTOMATIC LIGHTNING ARRESTER; G. P. Johnson, Gloversville, N. Y. App. filed Jan. 9, 1896 In combination with the circuit wires and a magnet, a fixed stud, an armature pivoted to said stud, a lever attached at one end to the said armature, a removable stationary contact-plate provided with an opening and normally supporting the free end of the said lever, a shouldered post on which the said plate fits and by which it is supported, means for clamping the said plate on the said post and a spring connected to the said lever which normally holds it in contact with said plate and the said armature out of contact with the magnet.

570,410. ELECTRIC ELEVATOR; F. B. Perkins, Boston, Mass. App. filed Sept. 7, 1895. The combination with a motor, an elevator mechanism actuated thereby, a starting and stopping mechanism, and a brake mechanism for said elevator mechanism, of an electrically controlled connection in circuit with said motor, and connecting said brake mechanism with said starting and stopping mechanism, and an electrically controlled locking device to lock said starting and stopping mechanism.

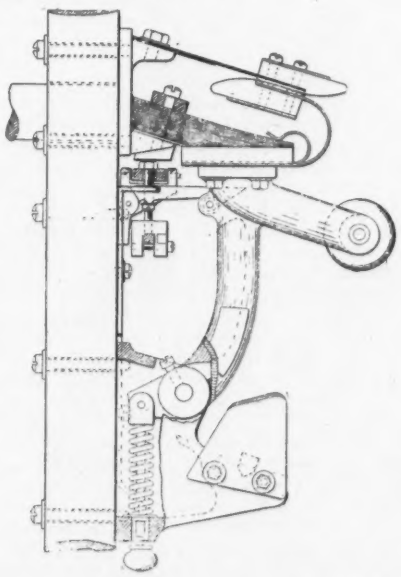
570,411. ELECTRIC LIGHT FIXTURE; G A. Schmidt, Brooklyn, N. Y. App. filed Dec. 10, 1895. In an electric light fixture, the combination with the stem of the fixture and its ornamental shell, of a canopy made in two parts, one being cup-shaped and secured between the upper end of the ornamental shell, and a collar or nipple on the fixture stem, and the other part being adjustable longitudinally on the stationary part.

570,415. CIRCUIT-BREAKER; A. J. Wurts, Pittsburg, Pa. App. filed Aug. 31, 1895. In an automatic circuit-breaker, a controlling magnet having a coil in the circuit to be interrupted in combination with circuit-closing means for rendering said magnet inactive, said circuit-closing means being independent of said magnet and located in and forming a part of the main circuit, whereby an excessive current in said circuit serves to actuate said means.

570,416. CIRCUIT-INTERRUPTING DEVICE; A. J. Wurts, Pittsburg, Pa. App. filed Aug. 31, 1895. In a multiphase system of distribution, the combination with a circuit interrupted common to all the phases of the system, a normally open local circuit and a controlling magnet included therein, of circuit closers for the local circuit, one for each phase of the system, an overload upon any one of the main circuits serving to actuate the circuit-closing device and thus close the local circuit.

570,417. AUTOMATIC CIRCUIT-BREAKER; A. J. Wurts, Pittsburg, Pa. App. filed Jan. 10, 1896. In a time-limit circuit-breaker for alternating-current multiphase circuits, the combination with a plurality of pairs of stationary contact-terminals, one pair for each line conductor and a plurality of bridging contacts having a double movable support, of a latch, an armature for effecting the withdrawal of the same, primary and secondary armature-controlling coils, the latter being in normally open circuit and a plurality of devices respectively actuated by excessive current of the corresponding phase to close the secondary circuit a pre-determined interval of time after the occurrence of such excessive current.

570,418. SWITCH FOR ELECTRIC CIRCUITS; A. J. Wurts, Pittsburg, Pa. App. filed May 8, 1896. A switch for electric circuits comprising main contacts, auxiliary contacts in shunt thereto, and a single operating handle, the movable contacts having a limited movement independent of each other, and the shunt contacts having a retarding connection with a stationary part of the switch, whereby the circuit is closed through the main contacts and opened at the shunt contacts.



No. 570,419.—Circuit-Breaker.

570,419. CIRCUIT-BREAKER; A. J. Wurts, Pittsburg, Pa. App. filed May 29, 1896. In a circuit-breaker or switch the combination with main-contact terminals, of a shunt around the same provided with separable contacts each of which has a metal portion and an infusible-conducting portion so arranged that the current will be first shunted through the metal and then brought through the infusible portions.

570,424. ELECTRIC MOTOR; S. G. Brinkman, New York, N. Y. App. filed June 27, 1895. The combination in an electromotor of the armature-shaft with a pair of heads or spiders supported thereon, a jacket supported by the heads or spiders and armature-plates and coils enclosed by the jacket, the ends of the jacket being in contact with the outer edges or teeth of the spider.